FEASIBILITY STUDY REPORT

OMC PLANT 2
Waukegan, Illinois

Remedial Investigation/Feasibility Study

WA No. 018-RICO-0528/Contract No. EP-S5-06-01

December 2006

Executive Summary

This feasibility study report presents the results of the remedial action objectives (RAOs) development, technology screening, and alternative development and evaluation completed for the Outboard Marine Corporation (OMC) Plant 2 site. The objective of the feasibility study was to develop alternatives that will remediate or control contaminated media remaining at the site to provide adequate protection of human health and the environment.

RAOs for the media of concern were developed to protect human health and the environment based on the nature and extent of the contamination, resources that are currently and potentially threatened, and potential for human and environmental exposure as determined by the human health and ecological risk assessments. To meet the RAOs, preliminary remediation goals (PRGs) were developed to define the extent of contaminated media requiring remedial action at the OMC Plant 2 site.

Consistent with the RAOs and PRGs, remedial technologies and process options were identified and screened. Remedial technologies and process options that remained after screening were assembled into a range of alternatives. The potential alternatives encompass, as specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume of wastes, but vary in the degree to which long-term management of residuals or untreated waste is required.

Based on the risks present at the site and the remaining remedial technologies and process options available after completion of the screening, the following alternatives were assembled and then evaluated against the seven criteria identified in the NCP. As required, a no further action alternative was also evaluated.

Groundwater	**DNAPL**
Institutional Controls & Monitored Natural Attenuation	Institutional Controls & Monitoring
In Situ Chemical Reduction	Extraction, Onsite Collection, & Offsite Destruction
Enhanced In Situ Bioremediation	In Situ Thermal Treatment
Groundwater Collection & Treatment to MCLs	In Situ Chemical Reduction Treatment
In Situ Thermal Treatment	
Groundwater Collection & Treatment with Monitored Natural Attenuation	
Soil & Sediment	**OMC Building**
Excavation & Offsite Disposal	Demolition & Offsite Disposal
Excavation, Offsite Disposal, & Onsite Consolidation	Demolition, Offsite Disposal, & Onsite Consolidation
Excavation, Offsite Disposal, & Onsite Consolidation with Harbor Sediments	Demolition, Offsite Disposal, & Onsite Consolidation with Harbor Sediments

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Acronyms and Abbreviations

°F	degrees Fahrenheit
μg/100 cm^2	micrograms per 100 square centimeters
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
ACM	asbestos-containing material
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	contaminant of concern
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
ELCR	excessive lifetime cancer risk
EO	Executive Order
EPRI	Electric Power Research Institute
ERA	ecological risk assessment
ERH	electrical resistance heating
FR	*Federal Register*
FS	feasibility study
FSP	field sampling plan
ft/ft	foot per foot
g/kg	grams per kilogram
GAC	granular activated carbon
HHRA	human health risk assessment
HI	hazard index
IAC	Illinois Administrative Code
IC	institutional control
IEPA	Illinois Environmental Protection Agency
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction
ISTD	in situ thermal desorption
IWQS	Illinois Water Quality Standards
LDR	land disposal restriction
MCL	maximum contaminant limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIP	membrane interface probe
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	operations and maintenance
OMC	Outboard Marine Corporation
OU1	Operable Unit 1
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
POTW	publicly owned treatment works
ppm	parts per million
PRG	preliminary remediation goal
RAO	remedial action objective
RATM	Remedial Alternatives Technical Memorandum
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SOW	statement of work
SPH	Six-Phase Heating™
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TACO	Tiered Approach to Cleanup Objectives
TBC	to be considered
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TMV	toxicity, mobility, or volume
TSCA	Toxic Substance Control Act
USC	United States Code
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UTS	Universal Treatment Standard
UV	ultraviolet
VOC	volatile organic compound
WA	Work Assignment
WCP	Waukegan Coke Plant
ZVI	zero valent iron

SECTION 1
Introduction

1.1 Purpose

This feasibility study (FS) report presents the results of the remedial action objectives (RAOs) development, technology screening, and alternative development and evaluation completed for the Outboard Marine Corporation (OMC) Plant 2 site in Waukegan, Illinois. The work is being performed for the U.S. Environmental Protection Agency (USEPA) in accordance with the statement of work (SOW) for Work Assignment (WA) No. 018-RICO-0528.

As described in the SOW and the remedial investigation (RI)/FS work plan (CH2M HILL 2004a), those alternatives that will remediate or control contaminated media (building materials, soil/sediment, and groundwater) remaining at the site to provide adequate protection of human health and the environment were evaluated. The potential alternatives encompass, as specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume (TMV) of wastes, but vary in the degree to which long-term management of residuals or untreated waste is required. The assembled alternatives were then evaluated in accordance with the seven NCP evaluation criteria.

The general objectives of this FS include the following:

- Identify site-specific RAOs
- Develop general response actions for each medium of interest
- Identify and screen applicable remedial technologies for effectiveness, implementability, and cost
- Develop remedial alternatives
- Analyze the alternatives in accordance with the seven NCP criteria

1.2 Organization

This FS report consists of five sections. Section 1 provides an introduction and summarizes background information, such as site physical description, previous removal actions, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, and the human health and ecological risks.

The development of the RAOs and preliminary remediation goals (PRGs) are discussed in Section 2. Chemical-specific remedial goals were developed for the building materials, soil/sediment, and groundwater based on risk associated with the various concentrations of contaminants in those media, the applicable or relevant and appropriate requirements (ARARs), and background concentrations when applicable. A detailed review of ARARs for this site is provided in Appendix A.

Section 3 contains information about the general response actions that address the RAOs and introduces the identification and screening of the technology types and process options. Remedial technologies were screened to focus the detailed analysis on only those technologies most applicable to the site.

In Section 4, the screened technologies were developed and assembled into remedial action alternatives that achieve some or all of the RAOs, provide a range of levels of remediation, and a corresponding range of costs.

A detailed analysis of the alternatives for the different media is presented in Section 5. The detailed analysis addresses the NCP evaluation criteria. Two additional criteria to be used in the evaluation of alternatives and the selection of a remedy—state/federal acceptance and community acceptance—will be addressed following public comment on the FS. The basis and detailed cost estimates for the alternatives are provided in Appendix B.

Reference documents used during the performance of the alternatives screening and preparation of this memorandum are included in Section 6.

1.3 Site Description

The following sections briefly describe the physical location of the site; its operational history; the geologic, hydrogeologic, and ecological setting; the nature and extent of contamination; contaminant fate and transport; and summary of human health and ecological risks. Additional information on the site is presented in the field sampling plan (FSP; CH2M HILL 2004b) and the RI report (CH2M HILL 2006).

1.3.1 Site Location

The OMC Plant 2 site is located at 100 E. Seahorse Drive, Waukegan, Illinois (Figure 1-1). The 65-acre site includes a 1,036,000-square-foot former manufacturing plant building (Plant 2) and several parking lot areas to the north and south of the building complex (Figure 1-2). The site includes two polychlorinated biphenyl (PCB) containment cells in which PCB-contaminated sediment (dredged from Waukegan Harbor in the early 1990s) and PCB-impacted soil are managed. The cells (the East Containment Cell and the West Containment Cell) are located north of the plant building.

The site is situated in an area of mixed industrial, recreational, and municipal land uses (Figure 1-2). The OMC facility is bordered to the north by the North Ditch and North Shore Sanitary District and to the east by the public beach and dunes along Lake Michigan. Sea Horse Drive forms the southern site boundary. Railroad tracks operated by the Elgin, Joliet, and Eastern Railway Company, and the A. L. Hanson Manufacturing Company (formerly OMC Plant 3) are located to the west of OMC Plant 2.

1.3.2 Background

OMC designed, manufactured, and sold outboard marine engines, parts, and accessories to a worldwide market for many years. Plant 2 was a main manufacturing facility for OMC; the major production lines used PCB-containing hydraulic and lubricating/cutting oils, chlorinated solvent-containing degreasing equipment, and smaller amounts of hydrofluoric acid, mercury, chromic acid, and other similar chemical compounds.

OMC filed for bankruptcy protection on December 22, 2000, and later abandoned the property after completing a limited removal action. In November 2001, the bankruptcy trustee filed a motion to abandon OMC Plant 2. The bankruptcy trustee negotiated an emergency removal action scope of work with USEPA and Illinois Environmental Protection Agency (IEPA) that was approved by the court on July 17, 2002. The waste removal activities for the OMC Trust were completed in November 2002 and the Trust abandoned the OMC Plant 2 property on December 10, 2002.

USEPA assumed control of building security and utilities on December 10, 2002, and commenced a removal action to clean up more of OMC Plant 2 in spring 2003. The City of Waukegan took title to the OMC Plant 2 property in July 2005 and is responsible for maintaining the building, property, and operation and maintenance (O&M) of the containment cells.

1.3.3 Previous Remediation and Removal Actions

Since the late 1970s, the OMC complex has been subject to investigation and remediation (primarily for PCBs). The information on the remedial activities conducted at the site is briefly summarized below.

Waukegan Harbor Remediation

Reports indicate that from 1961 to 1972 OMC purchased about 8 million gallons of hydraulic fluid containing PCBs to use as a lubricant in its aluminum die casting machines. During the manufacturing process, some of the hydraulic fluid spilled into floor drains that discharged to an oil interceptor system. As a result, large quantities of PCBs were released directly to Waukegan Harbor in the western end of former Slip 3 and on the OMC property into the North Ditch, Oval Lagoon, Crescent Ditch, and the parking lot. By the time the discharge pipe to the harbor was sealed in 1976, about 300,000 pounds of PCBs had been released into the Waukegan Harbor and another 700,000 pounds to the OMC property near the North Ditch (USEPA 2002).

In September 1983, Waukegan Harbor and the North Ditch area (Operable Unit 1 [OU1] and OU3) were placed on the National Priorities List (NPL). OMC financed a trust to implement the cleanup and to ensure performance of the requirements of the Consent Decree with USEPA (dated April 1989). The final remedy included the following (USEPA 2002):

- Construction of cutoff walls to isolate PCB-contaminated materials and to make Slip 3 a permanent containment cell. Designated dredged harbor sediments were placed in Slip 3 for containment.
- Excavation and construction of a new boat slip (Slip 4) on the east side of the North Harbor on the Waukegan Coke Plant (WCP) property for the relocation of Larsen Marine Service from Slip 3.
- Construction of two other containment cells (termed the East and West Containment Cells) on the OMC Plant 2 property (Figure 1-2). The East Containment Cell encompasses the Plant 2 parking lot area and the land east of the lot. The West Containment Cell encompasses the Crescent Ditch and Oval Lagoon. Before construction, all areas containing PCB contamination at concentrations greater than 10,000 parts per million (ppm) were excavated and removed for treatment. Soil

excavated from the parking lot area did not require treatment before placement into the East Containment Cell because it did not exceed the treatment criterion. About 5,000 cubic yards of sediment and soil were removed from the North Ditch, 2,900 cubic yards from Oval Lagoon, and 3,800 cubic yards from Crescent Ditch.

- Placement of residual soils from the treatment of materials in hot spot areas by a low-temperature extraction procedure into the West Containment Cell, which was then closed and capped.
- Restoration of the North Ditch by excavation of designated sediments, placement of these sediments in the West Containment Cell, and backfilling of the North Ditch with clean sand.
- Installation and operation of an extraction well system at each containment cell to prevent the migration of PCBs from the cells by maintaining an inward hydraulic gradient. Treatment of extracted water using dedicated water treatment systems with discharge to the North Ditch or Waukegan Harbor.

Final construction activities for the Waukegan Harbor (OU1 and OU3) remedial action were completed in December 1994. O&M of the containment cells is ongoing.

Underground Storage Tank and Aboveground Storage Tank Investigations and Remediation

As a result of a tightness test that detected a leak in underground storage tank (UST) Tank 2.6, OMC removed six USTs in 1993 and performed a closure assessment. The closure assessment report indicates that five of the tanks were in good condition upon removal. Two small holes were observed in the bottom of Tank 2.6. On the basis of soil staining, strong petroleum odors, and sheen on groundwater entering the excavation, IEPA was notified that a release had occurred (Sigma 1993).

OMC's Removal Action

The waste removal activities for the OMC Trust were conducted beginning in August 2002 and were completed in November 2002. The completed tasks included removing and disposing of all drums and containers, draining of all tanks, draining and flushing of all transformers, draining and disposing of all hydraulic fluid remaining in machines, draining and disposing of all fluids in the chip wringer and hopper machine, and removing and disposing of all batteries and capacitors. The OMC Trust abandoned the Plant 2 property on December 10, 2002.

USEPA Removal Action

USEPA assumed control of building security and utilities on December 10, 2002, and commenced a removal action between May 12 and July 11, 2003. USEPA's activities consisted of waste removal, floor decontamination, site security, O&M of the sediment containment cells, tunnel inspections, soil and groundwater sampling, asbestos removal, and draining and disposal of PCB-contaminated transformer fluid. Wastes removed included hydraulic oil, machining oil, oily metal chips, sludge, compressed gasses, and waste decontamination water. The chip wringer pit, metal working floor, former parts storage area floor, and floor in the old die cast area were cleaned. Floor decontamination efforts reduced PCB concentrations on the floors, but remaining concentrations exceed standards in five of nine metal working area wipe samples collected following floor cleaning (Tetra Tech 2003).

Friable asbestos-containing material (ACM) was identified on three pressure vessels in the north boiler room and was targeted for removal. ACM associated with venting and external piping in the western part of the plant also was removed (Tetra Tech 2003).

OMC had numerous PCB transformers that were mounted on the roof or on pads in the building and equipped with curbing. Seven PCB capacitors were reportedly also located within the Plant 2 facility. Transformers were drained and replaced with non-PCB containing fluid during removal activities conducted by the OMC Trust in 2002. After 90 days of use, USEPA sampled 23 of the plant's transformers that were historically filled with PCB-containing dielectric fluids and found PCB concentrations (ranging from 9,600 to 59,000 milligrams per kilogram [mg/kg]), which still exceeded regulatory limits. As part of USEPA's removal activities in July 2003, the electrical transformers were de-energized and the PCB-containing fluid was drained from all except one of the transformers. After being drained, the plugs were replaced and the transformers were left empty with the power disconnected. One transformer (#8) was left full of fluid and energized because it was determined that the transformer supplied the Plant 2 guard house, phone, and fire alarm systems with power.

Assessment of the Lakefront Study Area

The City of Waukegan conducted an environmental site investigation of the lakefront study area in July and October 2004 and May 2005. PCBs were detected over most of the dune area at depths of up to 8 feet. Elevated concentrations of PCBs (greater than 1 mg/kg) were in the northern portion of the study area, especially east of the East Containment Cell. This area south of the North Ditch and east of the containment cell include three locations containing PCB concentrations greater than 100 mg/kg. The City's investigation results estimate that there is approximately 3,300 cubic yards of material with PCB concentrations greater than 10,000 micrograms per kilogram (µg/kg) in this area (Deigan and Associates, LLC 2004).

In August 2005, the USEPA Emergency Response Branch collected additional soil samples from the dune area east of the main plant in response to the PCB concentrations in soils detected during the City of Waukegan's investigation. Sample locations were selected to coincide with locations sampled by the City of Waukegan or to provide better resolution of potential excavation areas. Samples collected by USEPA in August 2005 confirm the PCB concentrations detected by the City of Waukegan (Tetra Tech 2005).

1.3.4 Remedial Investigation

OMC and USEPA have conducted multiple investigations at the site and in its vicinity. Since the late 1970s, a large body of geologic, hydrogeologic, hydrologic, and chemical distribution information has been developed during investigations conducted. The data needs and investigation approach for the site were developed based on the conceptual model developed from the existing data, potential environmental issues, and future land use goals. The field investigation was conducted at the OMC Plant 2 site between January and June 2005. The data collection activities included the following:

- An investigation of the building materials including collection of PCB wipe samples from porous and nonporous surfaces and concrete core samples to evaluate material handling and disposal options

- An investigation of the storm sewers to determine if they continue to discharge to Waukegan Harbor
- Surface and subsurface soil sampling to define the nature and extent of contamination within the footprint of the building and surrounding areas
- A membrane interface probe (MIP) investigation to delineate the extent of volatile organic compounds (VOCs) in the subsurface
- Monitoring well installation and groundwater sampling to verify groundwater quality conditions, including data to determine if conditions are conducive for natural attenuation
- An investigation to determine the extent of the dense nonaqueous phase liquid (DNAPL) encountered during the MIP investigation

1.3.5 Additional Investigations and Removal Actions

In addition to the CH2M HILL field investigations, the City of Waukegan and USEPA also collected soil samples from the dune area to the east of the site. Additional wipe sampling was also conducted in August within the Triax Building by Conestoga-Rovers & Associates for the Waukegan Coke Plant Settling Defendants. These data were incorporated into the nature and extent of contamination and risk assessment discussions presented in the RI report (CH2M HILL 2006).

High levels of PCB contamination were found in the dune area soils by the investigations conducted by the City of Waukegan and the USEPA. The highest PCB concentrations (730 mg/kg) were detected in samples near the North Ditch and east of the East Containment Cell. In response to the PCB contamination, USEPA conducted a removal action in December 2005. Soils were excavated from two areas along the fence line adjacent to the East Containment Cell and an area in the South Ditch. The excavations adjacent to the East Containment Cell included a north area running about 160 feet north to south along the fence line that was about 47 feet wide and 3 feet deep. The second area near the fenceline was about 105 feet wide and 125 feet long and was excavated to depths of 6 feet. The sediment in the South Ditch was removed to a depth of about 2 feet from an area about 8 feet wide and 150 feet long. The excavations were backfilled and surface restored. Approximately 9,743 tons of PCB-contaminated soil were transported to and disposed of at the Onyx Zion Landfill in Zion, Illinois, in May 2006 (Tetra Tech EM Inc, 2006).

1.4 Physical Site Setting

1.4.1 Local Demography and Land Use

Current Conditions

The current land use in the vicinity of OMC Plant 2 is primarily marine-recreational and industrial, but also includes utilities and a public beach east of the site (Figure 1-2). Waukegan Harbor, south of the site, is an industrial and commercial harbor used by lake-going freighters and recreational boaters. The Larsen Marine Service property lies between the OMC Plant 2 site and Waukegan Harbor. Larsen Marine Service uses Slip 4 for repair, supply, and as docking facilities for private boats.

The Lake County Board and the City of Waukegan classified land use areas in Lake County in 1987. Land surrounding the northern portion of Waukegan Harbor is classified as urban, while the beach areas and water filtration plant properties are classified as open-space areas. The remaining land in the immediate harbor area is classified as special use (Lake County) or residential (City of Waukegan).

The site, surrounding properties, and the City of Waukegan obtain potable water from Lake Michigan. The city has no municipal potable wells. There are some private residential wells within the city limits at a distance from the site (URS 2000).

Future Land Use

In December 2000, OMC declared Chapter 11 bankruptcy, and began liquidation in August 2001. Subsequently, the City of Waukegan purchased the WCP site and also acquired the OMC Plant 2 property (Figure 1-2). The WCP and the OMC Plant 2 sites were rezoned to high-density residential, and the City and other entities are working to revitalize the Waukegan lakefront area.

In December 2003, the City of Waukegan amended its 1987 Comprehensive Plan to include the Waukegan Lakefront-Downtown and Lakefront Master Plan and supporting documents prepared by Skidmore, Owings & Merrill, LLP and its consulting team (City of Waukegan Ordinance No. 03-O-140). The master plan and documents provided by the City of Waukegan were reviewed with respect to the anticipated future land use of OMC Plant 2 and surrounding properties. The plan defines the northern portion of the OMC Plant 2 property as an "eco-park" development that transitions to mixed-use marina-related commercial and residential use on the southern portion of the property. Similar plans are anticipated for the WCP site. The City is in the early stages of its process of rezoning various lakefront parcels consistent with the master plan (Deigan 2004). A concept of the City's vision for the harbor area is presented in Figure 1-3.

1.4.2 Geologic Setting

The subsurface materials encountered include near-surface fill materials above a naturally occurring sand unit that overlies clay till. The fill deposit extends from 2 to 12 feet below ground surface (bgs). Underlying the fill is a poorly graded sand or silty sand to a depth of about 25 to 30 feet. This relatively permeable sand unit comprises an unconfined aquifer with a geometric mean hydraulic conductivity of about 2.0×10^{-2} centimeters per second (cm/sec) and an average porosity of about 30 percent. Beneath the sand unit is 70 to 80 feet of hard gray clay that forms the lower boundary of the unconfined aquifer.

1.4.3 Hydrogeologic Setting

Groundwater is shallow and was encountered at depths ranging between 2 and 7 feet, depending on the ground surface elevation. Groundwater flow is generally west to east across the northern portion of the site (toward Lake Michigan) and in the southern portion of the site groundwater flows toward the south (toward Waukegan Harbor). The horizontal gradient is flat beneath the building and increases toward the south. The overall average site gradient is estimated to be 0.002 foot per foot (ft/ft). The calculated groundwater velocities ranged from about 70 to 150 feet/year in the shallow zone and 6 to 30 feet/year in the deeper zone of the aquifer. The overall site average groundwater velocity is estimated to be about 70 feet/year. Vertical gradients between the shallow and the deeper portions of the aquifer are almost non-existent.

1.4.4 Ecological Setting

The most significant ecological feature is the 13-acre area on the easternmost side of the OMC Plant 2 property, extending from the North Shore Sanitary District's southern property boundary including the North Ditch to the South Ditch (Figure 1-2). This portion of Waukegan Beach has never been developed with surface structures and is generally inaccessible. Wooded areas have been re-established east of the former seawall barrier and extend from the North Ditch to the South Ditch. Most of the remaining portions of the Waukegan Beach east of this tree line are rolling sand dunes with sporadic tree and natural grass land cover that lead eastward to a gently sloping beach.

Three wetland areas are represented by drainage ditches on the north and south edges of the area and by a small depression along the North Ditch near the lakeshore. A narrow terrace along the north side of the South Ditch contained significant amounts of conservative wetland species.

The Illinois Department of Natural Resources identified 13 plants species, 1 invertebrate species, and 5 bird species that are threatened or endangered (federal or state) and occur within 1 mile of OMC Plant 2 (Kieninger 2005). The piping plover is the only threatened or endangered (federal or state) bird species known to have nested in the beach area east of the OMC Plant 2 site (IEPA 1994). Four threatened or endangered plant species have been found at Waukegan Beach. The species are American sea rocket (*Cakile edentula;* state-threatened), seaside spurge (*Chamaesyce polygonifolia;* state-endangered), American beachgrass (*Ammophila breviligulata;* state-endangered), and Kalm's St. John's wort (*Hypericum kalmianum;* state-endangered).

1.5 Nature and Extent of Contamination

The findings of the field investigation relative to the nature and extent of contamination at the OMC Plant 2 site are described below.

1.5.1 Building Materials and Sewer Testing

The OMC Plant 2 building materials were sampled to evaluate material handling and disposal options. During removal activities conducted by USEPA, PCB contamination was identified in the old die cast, parts storage, and metal working areas. Building materials were grouped and sampled according to surface material porosity as defined in 40 Code of Federal Regulations (CFR) 761.

Nonporous Surfaces—Metal Structures and Piping

Analytical results from wipe sampling indicate nonporous metal surfaces with concentrations of PCBs exceeding the 10 micrograms per 100 square centimeter (µg/100 cm^2) Toxic Substances Control Act (TSCA) disposal criteria are present throughout the OMC Plant 2 building, with the exception of the northeast corner of the metal working area where no nonporous surfaces were present. In addition, nonporous surfaces in the old die cast, parts storage, and metal working areas have concentrations of PCBs exceeding the second-tier TSCA disposal criteria of 100 µg/100 cm^2.

PCBs were detected in nonporous samples throughout all sampled building areas, but at wide-ranging concentrations. The general trend of detected PCBs on nonporous surfaces indicates the highest concentrations in the old die cast and parts storage areas with concentrations decreasing outward from these areas.

Porous Floor

Samples collected from concrete floors within the OMC Plant 2 building indicate the presence of PCBs at concentrations exceeding the 50 mg/kg TSCA disposal criteria established in 40 CFR 761. The distribution of PCBs in concrete generally coincides with wipe sample results in the old die cast and parts storage areas, which have the highest detected concentrations that decrease outward. Concentrations of PCBs exceeding 50 mg/kg appear to be limited to concrete floors in the old die cast and parts storage areas or to approximately 25 percent of the total building floor area. Concentrations of PCBs below 50 mg/kg were detected in concrete floors in all areas of the plant.

Porous Surfaces Other Than Floors

Wipe sample results for porous surfaces other than floors indicate PCBs were detected in the old die cast, parts storage, and metal working areas of the OMC Plant 2 building. Paint chip and concrete samples were collected to determine disposal requirements for the materials where concentrations greater than 10 µg/100 cm^2 were detected in wipe samples from porous surfaces. Concentrations of PCBs exceed the TSCA disposal criteria for solids of 50 mg/kg in eight of the ten concrete and paint chip samples.

Sewer Testing

Sediment samples were collected from select manholes south of the OMC building. Sediment sampling was performed prior to completion of remedial investigation activities; however, analytical results from the sewer samples were not available until after completion of the remedial investigation.

The manholes west of the corporate building to the Triax Building were found to contain varying amounts of standing water and large volumes of sediment. The plugging of the storm sewer pipe appears to be effectively preventing discharge directly to Waukegan Harbor.

Sediment samples were collected for PCB analysis from seven storm sewer locations located south of OMC Plant 2. Sediment generally consisted of silty sand with trace organics and ranged from 4 to 30 inches in thickness. PCBs were detected in all of the sediment samples ranging from 0.2 to 130 mg/kg. Concentrations of PCBs greater than 1 mg/kg were detected in the storm sewer manholes located east of the corporate building and just north of East Seahorse Drive. The storm sewer in this area is reported to discharge to the east into the South Ditch or may extend south beneath the Larsen Marine Service property and discharge to Waukegan Harbor.

1.5.2 Soil and Sediment

A limited soil investigation was conducted to fill in data gaps identified based on the evaluation of existing data. Concentrations of PCBs and carcinogenic polynuclear aromatic hydrocarbons (PAHs) that exceed the TSCA self-implementing PCB cleanup level of 1 mg/kg (or 1 ppm) were found in shallow soil. Elevated PCB concentrations exceeding 1 ppm were detected across the site and in the dune area east of the plant. The majority of PCB concentrations in the soil beneath the plant were consistent with where the wipe and concrete core samples indicated the presence of PCBs.

The results indicate that the majority of the most contaminated soils were removed as part of OMC's remediation north of the building. The additional areas containing PCB- and/or carcinogenic PAH-contaminated soil include north of the plant in the vicinity of former loading docks and tank areas, and in the open area north of the trim building, the former die cast UST/aboveground storage tank (AST) area, and the dune area east of the plant. Elevated concentrations of carcinogenic PAHs were also found in the area surrounding the corporate building.

1.5.3 Dense Nonaqueous Phase Liquids

DNAPL was encountered at one location and was comprised of 1,600 grams per kilogram (g/kg) of trichloroethene (TCE). The extent of the DNAPL was investigated and not found at locations 50 feet around the MIP-027/SO-057 location. Concentrations of TCE indicative of residual DNAPL were detected in a saturated soil sample collected from a boring in the area of the chip wringer.

1.5.4 Groundwater

Groundwater contamination is mainly related to the use of chlorinated solvents, primarily TCE, in manufacturing operations at OMC Plant 2. The MIP, soil, and groundwater investigations indicated that the distribution of chlorinated volatile organic compounds (CVOCs) is limited in extent and appears as isolated areas rather than a single plume. The MIP investigation identified five areas of which three were confirmed by the soil and groundwater results. The CVOC plume extending south of the building does not appear to have migrated far offsite and does not extend to Waukegan Harbor. The components of the CVOC concentrations include TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride. The presence of TCE degradation compounds and results of natural attenuation parameters indicate that the TCE area is being degraded by anaerobic reductive dechlorination.

1.5.5 Soil Gas and Indoor Air

Soil gas and indoor air sampling investigations were conducted to determine if volatilization from the groundwater plume may cause a potential inhalation risk to human health. Five soil gas samples were collected from the unsaturated zone at locations south of the OMC site in the vicinity of Larsen Marine Service. In addition to the soil gas samples, indoor air samples were collected from two of the Larsen Marine Service buildings.

In general, similar compounds were detected in the indoor air investigation as were found in the soil gas investigation results. The relative concentrations of OMC-related compounds (e.g., TCE and cis-1,2-DCE) and the predominance of compounds not detected in the groundwater samples indicate that volatilization from groundwater is probably not the major source of the VOCs detected in the soil gas samples or the indoor air samples from the Larsen Marine Service buildings.

1.6 Contaminant Fate and Transport

The primary contaminant release and transport mechanisms occurring at the OMC Plant 2 site include the following:

- Volatilization of organic compounds from the building materials, soil and groundwater, and migration offsite through the atmosphere. Based on previous air sampling, PCBs may be volatilizing from the contaminated building material into the atmosphere. Volatilization of organic compounds from surface soil and groundwater is not considered a major loss mechanism based on physical properties of the surface materials.
- Leaching of contaminants from source materials, including DNAPL, into groundwater and subsequent dissolved phase transport to groundwater discharge areas such as surface water bodies (Lake Michigan or Waukegan Harbor) is considered the most significant transport mechanism occurring at the site.
- Surface runoff of contaminants to ditches, low lying areas, or surface water bodies by dissolving in stormwater runoff or by soil erosion. Based on the PCB contamination detected in the sediment in the North and South ditches, surface runoff has occurred in the past. Because of the site topography and the presence of the building, pavement, gravel, and vegetation covering most of the contaminated areas, the overall potential for continued transport of contaminated soils into offsite surface waters by erosion and surface flow is limited.
- The main contaminants in the surface soil (PCBs and carcinogenic PAHs) tend to be persistent in the environment because they are slow to degrade and have low mobility. The contaminants in the groundwater (CVOCs) have a higher mobility and are detected further away from the source areas. Based on the chemical properties of TCE, cis-1,2-DCE, and vinyl chloride and an average sitewide velocity, these CVOCs are estimated to travel at an average rate between about 40 and 60 feet/year, assuming no degradation of the CVOCs.

The groundwater data collected indicate that the chlorinated "parent compound" in groundwater (TCE) is being degraded by anaerobic dechlorination to transformation products (cis-1,2-DCE and vinyl chloride). Additionally, final and nontoxic degradation byproducts, ethane and ethene, were also detected at the site. Other natural attenuation data (geochemical and biochemical parameters) provide further evidence that the CVOCs are degrading in groundwater. Reductions in total CVOCs in groundwater, increases in daughter products, and trends in site conditions indicate that degradation is occurring. Continued natural attenuation monitoring is recommended to confirm trends in natural attenuation data and to evaluate seasonal variability as part of the evaluation of monitored natural attenuation (MNA) as a potential remedial approach.

1.7 Human Health Risk Assessment

A human health risk assessment (HHRA) was prepared using conservative assumptions and feasible exposure pathways that were based on current site conditions and both current and potential future site use. Use of these conservative assumptions (consistent with a reasonable maximum exposure scenario) was intended to overstate rather than understate the potential risks. The HHRA was performed initially using a risk screening analysis with risk-based concentrations obtained from the State of Illinois Tiered Approach to Cleanup Objectives (TACO) program. In addition to this streamlined screening approach, an exposure assessment and toxicity assessment were performed. These assessments were used to evaluate potential exposure pathways and receptors not addressed by TACO values, and to develop cumulative risk estimates for comparison with USEPA target risk reduction goals. The results from comparison with the TACO values indicated several chemicals of potential concern, principally PCBs and carcinogenic PAHs in soil, and CVOCs in groundwater.

The results from this screening and the exposure and toxicity assessments chemical indicate that, based on current soil and groundwater characterization data, the potential risks to human health were higher than USEPA target risk reduction objectives in different portions of the site. The estimated risks are based on the assumption that remedial actions are not conducted to address these concentrations. These estimated risks are also based on the assumption that the site is redeveloped for future residential and recreational uses. Chemicals in soil driving potential risks within the footprint of the OMC Plant 2 building principally are PCBs and carcinogenic PAHs. Chemicals in groundwater driving potential risks are CVOCs, including TCE and vinyl chloride. PCBs in soil within proposed future recreational areas to the north and east of the OMC Plant 2 building potentially drive human health risks in those areas. Under current conditions, there are no potentially complete exposure pathways with the exception of trespassers entering the OMC Plant 2 building. Potential contact with PCBs in building materials by these individuals is unlikely to represent human health risks higher than USEPA target risk reduction objectives.

An additional evaluation was conducted to estimate the potential risks to an industrial worker exposed to the contaminated surfaces existing in the plant. The estimated risks for an industrial worker exposed to the PCB-contaminated surfaces and materials while working in the existing plant building were higher than the USEPA target risk reduction objectives. The evaluation of the risk for the industrial worker is presented in Appendix C.

1.8 Ecological Risk Assessment

The ecological risk assessment (ERA) evaluated whether contaminants present at the site and surrounding areas represent a potential risk to exposed ecological receptors. The spatial extent of the ERA encompassed both onsite and offsite terrestrial habitat that currently exists or may be created as part of future development at the site. The ERA evaluated potential risks to terrestrial plant communities, threatened and endangered plant species, soil invertebrate communities, reptiles, birds, and mammals. Risks to receptors in aquatic habitat in the offsite dunes area, Lake Michigan, and Waukegan Harbor were not considered in the ERA. The methods and approaches used in this ERA were developed from applicable USEPA guidance for Region 5.

Based on the evaluation using conservative and more realistic exposure assumptions, potential risks from PCBs to ecological receptors currently exist in an isolated area in the offsite dunes area, and after future development in areas of created habitat with high concentrations of semivolatile organic compounds (SVOCs) and PCBs. In the offsite dunes area, an evaluation of the spatial distribution of PCBs in surface soil indicates a limited area associated with potential risks to soil flora, including threatened and endangered plant species, soil fauna, and small insectivorous mammals. However, following USEPA's proposed removal activities, risks to these receptors are considered acceptable, and no further investigation is required.

After future development, there are potential risks from SVOCs and PCBs to soil flora, including colonizing threatened and endangered plant species, soil fauna, and small mammalian insectivores if suitable habitat is created and the existing soil concentrations are reflective of post-development conditions. Potential onsite risks to ecological receptors after development can be minimized by several methods, including creating habitat in areas without elevated concentrations and by creating habitat on clean soil cover. However, because it is expected that the site will be significantly altered during the redevelopment, post-demolition conditions should first be characterized and soil removal should be considered for any "hot spots" that remain.

SECTION 2

Development and Identification of ARARs, RAOs, and PRGs

2.1 Summary of Applicable or Relevant and Appropriate Requirements

Remedial actions must be protective of public health and the environment. Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

Definitions of the ARARs and the "to be considered" (TBC) criteria are given below:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing a remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include IEPA TACO Tier 1 remediation objectives, USEPA drinking water health advisories, reference doses, and cancer slope factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. "Onsite" CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the NCP, 40 CFR 300.5, definitions of ARARs and as discussed in 55 Federal Register (FR) 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (for example, fees, permitting, inspection, reporting requirements) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Appendix A includes the chemical-specific, action-specific, and location-specific ARARs for the OMC Plant 2 site. The most important ARARs are discussed below. All potential ARARs are listed in Appendix A along with an analysis of the ARAR status relative to remediation of the OMC Plant 2 site.

2.1.1 Chemical-Specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the OMC Plant 2 site can be classified into three categories: (1) residual concentrations of compounds that can remain at the site without presenting a threat to human health and the environment; (2) land disposal restriction (LDR) concentrations that must be achieved if the contaminated media that either is a characteristic hazardous waste or contains a listed hazardous waste is excavated or extracted and later land disposed; and (3) effluent concentrations that must be achieved in treatment of groundwater for discharge to surface water or discharge to a publicly owned treatment works (POTW).

Residual Concentrations

There are no chemical-specific federal or Illinois ARARs for soils. TBCs for residual soil concentrations include the USEPA Region 9 PRGs and IEPA TACO remediation objectives. IEPA TACO remediation objectives are not ARARs because a facility may choose not to use them per 35 Illinois Administrative Code (IAC) 742.105 (a) and (b). These are discussed in detail in Section 2.3.

For groundwater, Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and the Illinois Water Quality Standards (IWQS; IAC Part 620) are ARARs. Illinois TACO remediation objectives are not ARARs but are similar to the IWQS.

Land Disposal Restriction Concentrations

The Resource Conservation and Recovery Act (RCRA) LDRs would apply to remedial actions performed at the OMC Plant 2 site if waste generated by the remedial action (for example, contaminated soil) contains a RCRA hazardous waste or is itself a characteristic hazardous waste. Listed hazardous wastes are not known to have been disposed at the OMC Plant 2 site. As a result, excavated soils would not be required to be managed as listed hazardous wastes. If excavated and removed from the area of contamination (that is, where the soil is "generated"), the soil may be a characteristic hazardous waste, such as a D040 toxicity characteristic hazardous waste for TCE (toxicity characteristic leaching procedure [TCLP] greater than 0.5 milligrams per liter [mg/L]).

Soil below the building slab has the greatest potential to be a characteristic hazardous waste, since TCE was widely used at the facility and it is a major groundwater contaminant. Extensive soil sampling below the slab was not conducted because of the relatively thin unsaturated zone and the difficulty in sampling below the concrete slab.

Generated soils that exceed the TCLP limit must be managed as a hazardous waste and must meet the LDR treatment standards for contaminated soil (40 CFR 268.49). The treatment standard for contaminated soil is the higher of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards (UTS). Treatment is required for the constituent (such as TCE) for which the soil is a characteristic hazardous waste as well as other "underlying hazardous constituents." Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (USEPA 1998).

Table 2-1 presents the UTS and the 10 times the UTS and the maximum measured concentration in soil for each contaminants of concern (COCs) at the OMC Plant 2 site. Based on the comparison of maximum measured concentration and 10 times the UTS, it appears that for soil that is a characteristic hazardous waste, treatment may be necessary for benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, PCBs, and TCE. In each case, most soil samples did not exceed 10 times the UTS. As a result, it is likely that only a minor portion of characteristic hazardous waste soil would require treatment prior to land disposal.

TABLE 2-1
Universal Treatment Standards for Contaminated Soil
OMC Plant 2 FS

Contaminants of Concern	UTS mg/kg	10x UTS mg/kg	Maximum Soil Concentration mg/kg	Potential for Soil to Require Treatment to Meet LDRs for Contaminated Soil Yes or No
Benzo(a)anthracene	3.4	34	47	Yes
Benzo(a)pyrene	3.4	34	40	Yes
Benzo(b)fluoranthene	6.8	68	51	No
Benzo(g,h,i)perylene	1.8	18	32	Yes
Benzo(k)fluoranthene	6.8	68	29	No
Dibenz(a,h)anthracene	8.2	82	13	No
Indeno(1,2,3,-c,d)pyrene	3.4	34	27	No
PCBs (sum of all isomers)	10	100	790	Yes
Trichloroethene[a]	6	60	1,300	Yes
Vinyl chloride[a]	6	60	0.19	No
Contaminant of Concern without Universal Treatment Standards				
Dibenzofuran				

[a]Chemical of concern only for groundwater. Included here because of potential to exceed TCLP limit TCE TCLP limit = 0.5 mg/L and VC TCLP limit = 0.2 mg/L.

2.1.2 Action-Specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important action-specific ARARs that may affect the RAOs and the development of remedial action alternatives are CERCLA, TSCA, and RCRA regulations.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA requires the selected remedy to meet the substantive requirements of all environmental rules and regulations that are ARARs unless a specific waiver of the requirement is granted. Waiver of ARARs may be requested (per NCP 300.430(f)(1)(ii)(C)) based on any one of six circumstances. It is not anticipated that any ARAR waivers under CERCLA will be necessary.

Toxic Substances Control Act

TSCA regulates the remediation of soils contaminated with PCBs under 40 CFR 761.61. If excavated for disposal it requires soil contaminated with PCBs at concentrations of 50 mg/kg or greater to be disposed of at either a hazardous waste landfill permitted under RCRA or at a chemical waste landfill permitted under TSCA. TSCA also has specific requirements for PCB cleanup levels for porous and nonporous surfaces that are intended for reclamation or disposal. These are ARARs for building demolition wastes.

The self-implementing requirements for onsite cleanup of PCB remediation waste under 40 CFR 761.61 are not ARARs for CERCLA sites but are considered TBCs. Remediation of soils to 1 mg/kg total PCB is the cleanup level for high-occupancy areas under TSCA and is generally used for CERCLA remediation of soils.

Resource Conservation and Recovery Act

RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside the area of contamination. Such alternatives could include excavation of materials (for example, soil). Requirements include waste accumulation, record keeping, container storage, disposal, manifesting, transportation, and disposal.

As discussed above, portions of the soil at the OMC Plant 2 site may be characteristic hazardous waste. If the soil is characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal. This includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a). The most likely LDR that would have to be met is the characteristic hazardous waste soil would have to be treated to 60 mg/kg TCE or 100 mg/kg PCB prior to disposal in a RCRA Subtitle C landfill. If the soil has no other underlying hazardous constituents, it could be treated to below the TCLP limit, rendering it nonhazardous and disposed in a Subtitle D landfill. Nonhazardous waste soil would be disposed in accordance with RCRA solid waste disposal requirements.

2.1.3 Location-Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. The most important location-specific ARARs for the OMC Plant 2 site are the following:

- Fish and Wildlife Coordination Act—Enacted to protect fish and wildlife when actions result in the control or structural modification of a natural stream or body of water. The statute requires that any action takes into consideration the effect that water-related projects would have on fish and wildlife, and then take action to prevent loss or damage to these resources.
- Endangered Species Act of 1973—Requires that federal agencies insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat. In the future redevelopment scenario, potential risks to threatened and endangered plant species that may colonize created habitat are present. Risks are a result of the current concentrations of SVOCs and PAHs in soil.
- Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands), 50 CFR § 6 Appendix A—These are TBCs. They set forth USEPA policy for carrying out the provisions of Executive Orders (EOs) 11988 and 11990. EO 11988 requires that actions be taken to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. EO 11990 requires that actions at the site be conducted in ways that minimize the destruction, loss, or degradation of wetlands. Small wetland areas are present along the North and South ditches between the OMC site and Lake Michigan.

2.2 Remedial Action Objectives

The USEPA Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (USEPA 1988a) and the NCP define RAOs as medium-specific or site-specific goals for protecting human health and the environment that are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. PRGs are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. These PRGs are developed and used in the FS, and they will be finalized in the Record of Decision (ROD) for the OMC Plant 2 site.

In this section, RAOs are developed for the media of concern at the OMC Plant 2 site. The media of concern include the OMC building, soil, sediment, and groundwater.

2.2.1 Remedial Action Objectives for OMC Building

There is a potential for unacceptable risks resulting from exposure to building surfaces by trespassers and future industrial workers. The COCs are PCBs, and the excess lifetime cancer risk (ELCR) to trespassers is estimated to be 2×10^{-5} and 2×10^{-3}, respectively. The

RAO is to develop alternatives that will mitigate these risks to trespassers and future industrial workers.

In addition, redevelopment of the site will require removal of portions of the building to be able to access contaminated soil below it as well as construct new residential or commercial buildings and infrastructure. The presence of the building has not allowed full characterization of the unsaturated zone soils below the concrete slab. Since the volume of soil below the slab requiring remediation is uncertain and will be known only after the slab has been removed, remediation of shallow soil below the floor slab is included as part of building remediation. In addition, soils immediately surrounding the building will also be included as part of building remediation. This soil may require remediation either as a result of unacceptable direct contact risk or because it may be a source of contamination to groundwater. Consequently, an additional objective for remediating this contaminated soil is to allow the goals for groundwater remediation to be met. The soil media discussed later addresses the remainder of soils outside the footprint of the building.

The RAOs for the OMC Plant 2 building include the following:

- Prevention of trespasser and future industrial worker exposure to PCBs, through contact, ingestion, or inhalation on building surfaces that present an ELCR greater than 1×10^{-4} to 1×10^{-6}.
- Removal building and concrete slab as necessary to allow site remediation.
- Prevention of residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents a hazard index (HI) greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}.
- Remediation of contaminated soils below the building slab, as necessary, to prevent leaching of contaminants to groundwater that result in groundwater in excess of MCLs, IWQS for Class I groundwater, or for contaminants without primary SDWA MCLs, the HI is greater than 1 or the ELCR is greater than 1×10^{-4} to 1×10^{-6}.

2.2.2 Remedial Action Objectives for Soil

There is a potential for unacceptable risks from exposure to onsite soil by future residents and construction workers and of exposure to the offsite area east of the site by recreational users. The risk assessment calculated an ELCR of 2×10^{-4} for residential exposure to onsite soil and an ELCR of 1×10^{-5} for construction worker exposure to onsite soil. The risk assessment estimated a HI of 4.9 and an ELCR of 1.5×10^{-4} for adolescents for the offsite soil east of the site as a result of PCBs. USEPA has remediated a portion of this soil through a removal action.

The ERA found potential risks to ecological receptors in an isolated area in the dunes east of the site. The USEPA removal action of PCB soils exceeding 10 mg/kg, though, will alleviate these potential risks, and therefore, additional remediation is not needed for ecological risks. The ERA also found that in a future site development scenario, created habitats in areas of high SVOCs and PCBs could result in potential ecological risks. The area of elevated SVOCs and PCBs in soil coincides with the areas presenting unacceptable risks to human health. As a result, RAOs and PRGs specific to protection of ecological receptors from exposure to soil contaminants are not needed.

The RAOs for onsite soil at the OMC Plant 2 site include the following:

- Prevention of residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Prevention of erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6})

The RAOs for offsite soil east of the site include the following:

- Prevention of recreational human user exposure, through contact, ingestion, or inhalation to contaminated soil that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6} for PCBs
- Prevention of erosion and transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6})

2.2.3 Remedial Action Objectives for Sediment

Investigations conducted prior to the RI found the sediments from the North and South ditches to have elevated concentrations of PCBs, exceeding the 1 mg/kg PCB cleanup level typically used for sediment. As a result, further sediment investigations conducted during the RI focused on identifying the volume of sediment contained in these ditches. The RAO for the sediment is remediation of sediment in the North and South ditches exceeding a PCB cleanup level of 1 mg/kg.

2.2.4 Remedial Action Objectives for Groundwater and DNAPL

There is a potential for unacceptable risk from residential indoor inhalation of vapors from groundwater onsite. The risk assessment calculated an ELCR of 6×10^{-4} for this exposure pathway. Also, there is a potential unacceptable risk from construction worker exposure to groundwater. The risk assessment estimated an ELCR of 6×10^{-4} and the HI of 7.

Although there are no current groundwater receptors at the OMC Plant 2 site, RAOs for groundwater were developed to minimize further migration of the contaminant plume and limit the time needed to remediate groundwater to below unacceptable risk levels. Groundwater within the DNAPL area onsite may not be able to be remediated to ARARs within a reasonable time, so the RAO was modified for this area.

The RAOs for remediation of groundwater and DNAPL at the OMC Plant 2 site include the following:

- Prevention of residential indoor inhalation of VOCs that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}.
- Prevention of construction worker exposure to groundwater, through contact, ingestion, or inhalation that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}.

- Remediate contamination in groundwater to concentrations below an HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6}within a reasonable time frame.
- Remediate DNAPL and groundwater within the DNAPL area to the extent practicable and minimize further migration of contaminants in groundwater.

2.3 Preliminary Remediation Goals

To meet the RAOs defined in Section 2.2, PRGs were developed to define the extent of contaminated media requiring remedial action. This section presents the PRGs and defines the volumes of affected media exceeding the PRGs that will be addressed in the FS process. In general, PRGs establish media-specific concentrations of COCs that will pose no unacceptable risk to human health and the environment. COCs are the list of chemicals that result in unacceptable risk based on the results of the risk assessment. The PRGs are developed considering the following:

- Risk-based concentration levels corresponding to an ELCR between 1×10^{-4} and 1×10^{-6}, a chronic health risk defined by an HI of 1, and/or a significant ecological risk. As discussed earlier, PRGs for ecological receptors are not needed at the OMC site because the areas presenting potential risk either have been remediated under the USEPA removal action or coincide with the areas presenting unacceptable human risk.
- Chemical-specific ARARs/TBCs including federal MCLs for groundwater, IWQS for Class 1 groundwater, and IEPA TACO Tier 1 remedial objectives for soil and groundwater. The TACO Tier 1 remediation objectives are TBCs and are set at the HI equals 1 and ELCR values at 1×10^{-6}. The ELCR values could be modified upward to represent the values corresponding to a cumulative risk of 1×10^{-4}.
- Background concentrations of specific constituents.

A summary of the PRGs for soil and groundwater exposure pathways at the OMC Plant 2 site are included in Tables 2-2 and 2-3, respectively. PRGs for the OMC building are not listed separately in the tables. Building surfaces such as walls, floors, and piping must be remediated in accordance with TSCA regulations. These regulations and action levels are presented in Appendix A.

2.3.1 Preliminary Remediation Goals for Soil

Based on the potential future exposure risks and the RAOs presented in Section 2.2.2, soil PRGs were developed for surface and subsurface soil, depending on residential or construction worker exposure. PRGs were not developed at this time to address the RAO to prevent leaching of soil contaminants to groundwater. This is because leaching is not a pathway of concern outside the building footprint. Within the building footprint, sufficient data are not available to evaluate this pathway or identify the COCs. Once the building slab is removed, additional sampling and analysis will be performed, and site-specific PRGs to address leaching will be developed at that time.

TABLE 2-2
Soil Preliminary Remediation Goals
OMC Plant 2 FS

Contaminant	Soil Background[a] (mg/kg)	Soil Preliminary Remediation Goals (mg/kg): USEPA Region 9 Risk-Based Concentrations	TACO Tier 1 Residential Soil Value: Ingestion	TACO Tier 1 Residential Soil Value: Inhalation	TACO Tier 1 Construction Worker Soil Value: Ingestion	TACO Tier 1 Construction Worker Soil Value: Inhalation
Volatile organic compounds (VOCs)						
Trichloroethylene[b]	-	[redacted]	58	5	1,200	[redacted]
Semivolatile organic compounds (SVOCs)						
Benzo(a)anthracene	[redacted]	0.62	0.9	NA	NC	NC
Benzo(a)pyrene	[redacted]	0.062	0.09	NA	17	NA
Benzo(b)fluoranthene	[redacted]	0.62	0.9	NA	NC	NC
Benzo(g,h,i)perylene	NA	NA	NA	NA	NC	NC
Benzo(k)fluoranthene	1.7	[redacted]	9	NA	NC	NC
Dibenz(a,h)anthracene	[redacted]	0.062	0.09	NA	NC	NC
Dibenzofuran	NA	NA	NA	NA	NC	NC
Indeno(1,2,3-c,d)pyrene	[redacted]	0.62	0.9	NA	NC	NC
Naphthalene	NC	56	NC	NC	4,100	[redacted]
PCBs[c]						
PCB-1248 (Arochlor 1248)		0.22	[redacted]	NA	NC	NC
PCB-1254 (Arochlor 1254)		0.22	[redacted]	NA	[redacted]	NA
PCB-1260 (Arochlor 1260)	-	0.22	[redacted]	NA	[redacted]	NA

[a] PAH soil background values approved by IEPA based on results of the Electric Power Research Institute(EPRI; *Final report on Background PAHs in Surface Soil in Illinois*).
Values are the lognormal 95th percentile for urban areas within a metropolitan statistical area having a population density of at least 1,000 people / square mile and a minimum population of 10,000.
Selected Soil PRG highlighted in bold with shaded background. Where the background value is higher than the lowest PRG, the background value is used as the PRG.
[b] TCE was a COC only for the construction worker exposure route in the risk assessment. As a result the construction worker PRG applies to subsurface soil. However if TCE is detected in surface soil it is compared against the residential PRG.
[c] The PCB PRG is 1 mg/kg based on the US EPA TSCA cleanup levels (40 CFR 761.61).
NC- Not a contaminant of concern
NA = Not available or not applicable.
TACO - Tier 1 Soil Remediation Objectives for Residential Properties - Appendix B, Table A (IEPA 2001).
TACO - Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties -Appendix B, Table B (IEPA 2001).

TABLE 2-3
Groundwater Preliminary Remediation Goals
OMC Plant 2 FS

Contaminant	Federal SDWA MCL (mg/L)	USEPA Region 9 Tap Water[a] (mg/L)	Illinois Water Quality Standard-Groundwater Class I (mg/L)	Illinois TACO Tier 1 Groundwater Criteria Class I (mg/L)	Groundwater Volatilization to Indoor Air (mg/L)
Volatile organic compounds (VOCs)					
Chloroform	0.0800	[illegible]	NA	0.0002	NC
cis-1,2-Dichloroethylene	0.070	[illegible]	0.070	0.070	NC
trans-1,2-Dichloroethene	[illegible]	1.20	0.100	0.100	NC
Trichloroethylene	0.005	[illegible]	0.005	0.005	0.0065
Vinyl chloride	0.002	[illegible]	0.002	0.002	0.0003
Pesticides/PCBs					
PCB-1016 (Arochlor 1016)	[illegible]	0.0096	0.0005	0.0005	NA
PCB-1248 (Arochlor 1248)	0.0005	[illegible]	0.0005	0.0005	NA
Metals					
Arsenic (Total)	0.010[b]	[illegible]	0.050	0.050	NA
Manganese (Total)	NA	8.80	[illegible]	0.150	NA

Notes:
Selected PRG highlighted in bold with shaded background.
[a]USEPA Region 9 PRG presented represent values for an ECLR of 1×10^{-5}
[b]Arsenic MCL of 0.01 mg/l was promulgated in 2001 and went into effect on January 23, 2006.
NC - Not a contaminant of concern
NA - Not available or not applicable.
TACO - Tier 1 Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route - Appendix B, Table E (IEPA 2001).

Soil PRGs for each of the site COCs and for each of the above pathways are presented in Table 2-2. Soil PRGs developed for residential protection from direct contact ingestion and inhalation exposures are based on USEPA Region 9 PRGs and are protective at a risk level of HI of 1 and ELCR of 1×10^{-6}. These PRGs were applied to shallow soils (less than 2 feet deep). PRGs developed for construction worker protection from direct contact ingestion and inhalation exposures were applied to all unsaturated zone soil (less than 5 to 8 feet deep). Where there was little difference in soil volumes exceeding the residential versus construction PRGs, the more conservative residential PRGs were used. This occurs for soils contaminated with carcinogenic PAHs and PCBs below 2 feet.

PAH PRGs also include soil background values because PAHs are found to be ubiquitous in urban environments. The PAH background values are those developed jointly by IEPA and the Electric Power Research Institute (EPRI) in the Final Report on Background PAHs in Surface Soil in Illinois. The background PAH values are presented on the IEPA Bureau of Land Web site: http://www.epa.state.il.us/land/index.html.

2.3.2 Preliminary Remediation Goals for Sediment

ARARs for sediment PCB remediation cleanup levels are not available. Based on USEPA policy for sediment remediation, the PCB PRG for sediment is 1 mg/kg.

2.3.3 Preliminary Remediation Goals for Groundwater

PRGs were developed for groundwater based on the RAOs discussed earlier. The SDWA federal MCLs, USEPA Region 9 PRGs, IWQS, and Illinois TACO Tier 1 values were compared to develop the groundwater PRGs. The federal MCLs and the Illinois values are the same for the three main COCs, TCE, cis-1,2-DCE, and vinyl chloride. The significantly lower USEPA Region 9 PRGs were used to ensure that the cumulative risk from ingestion of groundwater does not exceed the 1×10^{-4} ELCR value mandated by the NCP.

PRGs were also developed to address the RAO for volatilization of groundwater VOCs to indoor air. These values apply to TCE and vinyl chloride and are based on an ELCR of 1×10^{-6}. They were developed using the Johnson and Ettinger (1991) Model as described in the risk assessment (CH2M HILL 2006).

2.4 Contaminated Media Exceeding Preliminary Remediation Goals

The areas and depths of soil and groundwater that exceed the PRGs were developed by comparing results with the lowest applicable PRG. Below is a discussion of the media exceeding the PRGs.

2.4.1 OMC Building

The areas of the OMC building having PCBs on surfaces that present unacceptable health risks or exceed the 10 μg/100 cm² TSCA criteria are shown in Figure 2-1. These areas generally coincide with the areas of the building either known or suspected to have soil contamination.

2.4.2 Soil

The soil areas outside the building footprint with COC concentrations exceeding the PRGs for PCB and PAHs are shown in Figures 2-2 through 2-5 and 2-8. The estimated in situ volume of soil onsite exceeding the PRGs is 30,460 cubic yards. The majority of this is limited to the upper 2 feet. The residential PRGs were also applied to soil below 2 feet because of the potential for mixing of these soils with surface soils during site development and because of the limited amount of soil contamination below 2 feet outside the building footprint.

The estimated volume of soil exceeding the PRGs in the dune area east of the site is 2,575 cubic yards. This is in addition to the volume previously excavated and stockpiled onsite as part of the USEPA removal action.

2.4.3 Sediment

The entire length of the North and South ditches exceed the PCB PRG of 1 mg/kg. The estimated in situ sediment volumes are 3,500 cubic yards and 730 cubic yards for the North and South ditches, respectively.

2.4.4 Groundwater

Potential source areas identified using the MIP that contain CVOC concentrations that exceed the groundwater PRGs are presented in Figure 2-6.

The area exceeding the groundwater PRGs is defined by the area exceeding the PRGs for TCE and vinyl chloride of 0.028 and 0.2 micrograms per liter (µg/L), respectively (Figure 2-7). The areas exceeding the MCLs and the area exceeding 1 mg/L total CVOCs are also identified on Figure 2-7. These areas are included as potential target areas for active treatment. The area of groundwater exceeding the PRGs is estimated to be 59.5 acres. The areas exceeding MCLs and 1 mg/L total CVOCs are estimated to be 14 and 44 acres, respectively. The full saturated thickness of the sand aquifer is contaminated above PRGs in this area. The volume of groundwater exceeding PRGs is estimated at 174 million gallons, assuming an average saturated thickness of 30 feet and a porosity of 30 percent.

SECTION 3

Identification and Screening of Technologies

After the RAOs and PRGs were developed, general response actions consistent with these objectives were identified; general response actions are basic actions that might be undertaken to remediate a site (for example, no action, in situ treatment, or excavation and treatment). For each general response action, several possible remedial technologies may exist. They can be further broken down into a number of process options. These technologies and process options are then screened based on several criteria. Those technologies and process options remaining after screening are assembled into alternatives in Section 4.

The following sections present general response actions for each media that may be applicable to OMC Plant 2. The soil and sediment media were combined because the media present similar characteristics in depth and degree of contamination. Likewise, technology screening for DNAPL was combined with groundwater because of the limited DNAPL extent and the similarities in technologies addressing high concentration source area groundwater and DNAPL. Technologies suited to just DNAPL are identified and discussed separately.

3.1 General Response Actions for Building

The general response actions for the building at OMC include the following:

- No further action
- Institutional controls
- Containment
- Removal/treatment/disposal

Each general response action is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

3.1.1 No Further Action

The no further action response includes no action for the building except for what has already been implemented (that is, OMC and USEPA removal actions in 2002). The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

3.1.2 Institutional Controls

Institutional controls for the building consist of restricting access to the property through fencing or land use restrictions. At OMC, these measures would be used primarily for limiting human contact with the building materials.

3.1.3 Containment

Containment is used to minimize the risk of contaminant migration as well as prevent direct contact exposures. Consolidation and capping onsite are applicable technologies for the building materials.

3.1.4 Removal/Treatment/Disposal

Physical, chemical, or thermal technologies are used once the building is demolished. Physical processes include transferring the building materials to an approved onsite or offsite disposal area. Biological processes are not applicable. Chemical processes such as washing/flushing or thermal processes such as incineration to treat the material will also be evaluated. Treatment residue would be disposed of onsite if it no longer contained COC concentrations posing a risk to human health or the environment; otherwise disposal in a licensed, permitted disposal facility would be necessary.

3.2 General Response Actions for Soil and Sediment

The general response actions for soil and sediment at OMC include the following:

- No further action
- Institutional controls
- Containment
- In situ treatment
- Excavation/treatment/disposal

Each general response action is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

3.2.1 No Further Action

The no further action response includes no action for soil except for what has already been implemented (i.e., construction of the East and West Containment cells). The no further action response would not satisfy the RAO of preventing exposure to COCs; therefore, this action may not be feasible for OMC. The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

3.2.2 Institutional Controls

Institutional controls for soil and sediment consist of restricting access to contaminated soil and sediment through fencing or land use restrictions. At OMC, land use restrictions would be used primarily for limiting human contact with the contaminated soil and sediment.

3.2.3 Containment

Containment is used to minimize the risk of contaminant migration as well as prevent direct contact exposures. Surface controls such as grading and revegetating can be used to reduce infiltration of precipitation through contaminated soil and prevent further erosion and offsite transport of contaminated soil. Capping and subsurface barriers are two applicable remedial technologies that could also be used at OMC to limit exposure to contaminants, help prevent contaminant migration, and limit the infiltration of precipitation. In situ containment of sediment is not considered because of the potential for future erosion and the relatively limited extent.

3.2.4 In Situ Treatment

In situ treatment methods can be used to reduce the contaminant concentrations in soil. In situ methods that may be applicable to soil at OMC include primarily biological technologies, such as land treatment or in situ soil mixing. A wide variety of technologies are considered in screening, including soil vapor extraction (SVE), bioventing, and surfactant flushing. However, the relatively shallow location of contaminants, the type of contaminants, and high water table at OMC significantly reduce the number of viable in situ treatments. In situ technologies for sediment are limited because they are either too difficult to apply or are more destructive of the ecosystem (for example, in situ solidification) than protective.

3.2.5 Excavation/Treatment/Disposal

Physical, chemical, biological, or thermal technologies are used once soil or sediment is excavated. Physical processes include excavating the contaminated soil and sediment and transferring it to an approved onsite or offsite disposal area. Biological processes such as land farming will be evaluated. Chemical processes such as washing/flushing or thermal processes such as incineration to treat the soil to meet soil disposal criteria will also be evaluated. Treatment residue would be disposed of onsite if it no longer contained COC concentrations posing a risk to human health or the environment; otherwise, disposal in a licensed, permitted disposal facility would be necessary.

3.3 General Response Actions for Groundwater and DNAPL

The general response actions for groundwater at the OMC site include the following:

- No further action
- Institutional controls
- Containment
- In situ treatment
- Collection/treatment/discharge

Groundwater includes both the complete plume exceeding PRGs as well as several higher concentration source areas within the plume. DNAPL includes both the free-phase "pool" as measured as a separate phase during the RI and residual DNAPL, which is present in soils but by definition does not flow and is not extractable by pumping.

3.3.1 No Further Action

The no further action response includes no action for groundwater.

3.3.2 Institutional controls

Institutional controls such as access restrictions or a restrictive covenant on the property deed of the OMC site limiting intrusive activities on the property may be necessary either as a standalone action or in concert with other actions. Groundwater and surface water monitoring may also be necessary to track the direction and rate of movement of the groundwater contaminant plume as well as to track changes in DNAPL thickness and whether the DNAPL is migrating.

3.3.3 Containment

Containment refers to minimizing the spread of groundwater contaminants through active or passive hydraulic gradient controls. Active gradient control can be accomplished with pumping wells, while passive gradient control can be achieved using a slurry or sheet-pile wall. Containment of groundwater can be effective in preventing the release of contaminants from the source areas and their subsequent migration.

Containment of DNAPL may be through active or passive hydraulic gradient controls. Active gradient control can be accomplished with injection wells or trenches, while passive gradient control can be achieved using a slurry or sheet pile wall.

3.3.4 In Situ Treatment

In situ treatment of groundwater entails treating the groundwater while it is in the aquifer, which can be achieved by applying physical/chemical, biological, or thermal techniques. Examples of possible approaches to in situ treatment of CVOCs in groundwater include chemical oxidation, MNA, chemical reduction, permeable treatment beds, resistive heating, thermal desorption, and/or biological treatment technologies. In situ treatment can be directed at the high concentration source areas or throughout the plume.

DNAPL would be treated in situ with surfactant or solvent washing/flushing, thermal treatment, soil mixing, in situ chemical oxidation, or in situ chemical reduction.

3.3.5 Collection/Treatment/Discharge

In this response action, groundwater would be extracted from the aquifer using pumping wells. The contaminants would then be removed from the water by physical, physical/chemical, chemical, or biological treatment. Disposal of groundwater can be accomplished by surface infiltration, subsurface injection, discharge to the POTW, or discharge to surface water.

DNAPL would be extracted from the subsurface using wells. Enhancements for DNAPL extraction such as use of surfactants or cosolvents are also possible. The collected DNAPL would then be disposed of offsite.

3.4 Identification and Screening of Technology Types and Process Options

In this section, the technology types and process options available for remediation of building materials, soil, sediment, DNAPL, and groundwater are presented and screened. An inventory of technology types and process options is presented based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified in Sections 3.1, 3.2, and 3.3. Each technology type and process option is either a demonstrated, proven process, or a potential process that has undergone laboratory trials or bench-scale testing.

Each technology and process option is screened based on a qualitative comparison of effectiveness, implementability, and relative cost. This step may eliminate a general response action from the alternatives screening process if there are no feasible technologies identified. The objective, however, is to retain the best technology types and process options within each general response action and use them for developing remedial alternatives. The evaluation and screening of technology types and process options are presented in Tables 3-1 through 3-3 for building materials, soil/sediment, and groundwater/DNAPL, respectively. Those technologies and process options that are screened out based on effectiveness, implementability, and/or cost are highlighted in the tables.

As mentioned above, technology types and process options are screened in an evaluation process based on effectiveness, implementability, and relative cost. Effectiveness is considered the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present at the site. Additionally, the NCP defines effectiveness as the "degree to which an alternative reduces TMV through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed by the OMC site. At this point, the cost criterion is comparative only, and similar to the effectiveness criterion, it is used to preclude further evaluation of process options that are very costly if there are other choices that perform similar functions with similar effectiveness. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

The NCP preference is for solutions that utilize treatment technologies to permanently reduce the TMV of hazardous substances. Available treatment processes are typically divided into three technology types: physical/chemical, biological, and thermal, which are applied in one or more general response actions with varying results.

The technology types and process options remaining following screening and identified in the following sections are subject to refinement/revision based on further investigation findings, results of treatability studies, or recent technological developments.

3.4.1 Technology and Process Option Screening for the Building Materials

Table 3-1 presents a range of potentially applicable technology types and options for addressing the buildings at the site. The screening is intended to highlight the most important aspects of the technology relative to the screening criteria. The last column titled "Screening Comments" provides a summary of the rationale for rejection of a technology or process option.

TABLE 3-1
Remedial Technology Screening–Building Materials
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
No Action						
None	None	No further actions to address impacted soils.	None.	Implementable.	Zero.	Required for comparison.
Institutional Controls						
[redacted]						
Containment						
[redacted]						

TABLE 3-1
Remedial Technology Screening–Building Materials
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Capping of Rubbelized Building Slab	Native soil, clay cap, synthetic membranes, sealants, asphalt, concrete	Cap material placed over demolished concrete slab that is consolidated onsite along north perimeter of property.	Cap integrity must not be compromised by present and future land use activities. Effective in preventing direct contact, erosion and leaching of contaminants from concrete slab.	A cap over the demolished concrete slab is compatible with future site development assuming it is placed in a berm along northern site boundary.	Caps are generally the least expensive way to manage the human health and ecological risks effectively.	Retained.
[redacted]						
In Situ Treatment						
[redacted]						
Ex Situ Treatment						
[redacted]						

TABLE 3-1
Remedial Technology Screening–Building Materials
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical / Chemical	High pressure washing, solvent washing, scarifying, wiping	There are a variety of ex situ physical/chemical treatment methods for organic contaminants in soil. Most are not are applicable to PCBs in cement. Methods to decontaminate PCBs from porous and nonporous surfaces include high pressure washes, solvent washes, physical wiping of metal surfaces, and scarifying concrete surfaces.	Generally can be effective in reducing PCB concentrations to below criteria that allow metal recycling, concrete re-use or disposal as a solid waste.	Implementable for surficial PCB contamination. Scarifying to remove PCBs impregnated throughout concrete may not be implementable.	Labor intensity generally results in high cost to remove PCBs. However it may be cost effective for metal recycling or to reduce high costs for offsite disposal in TSCA landfill.	Retained.
Thermal		Thermal treatments are not applicable to building materials other than metals intended for recycling in smelters. TSCA has specific requirements for PCB contaminated metals recycling and these requirements are ARARs.	Effective in destroying PCBs. Smelters have TSCA monitoring requirements to verify effectiveness.	Technology is commercially available.	Costs are high for metals heavily contaminated with PCBs.	Retained for further evaluation.
Removal						
Excavation	Excavation/ Demolition	Demolition of building and concrete with ordinary construction equipment such as cranes, backhoes, bulldozers, and front-end loaders.	Effective in removing PCB contaminated material.	Technology is commercially available.	Relatively high cost for PCB contaminated structures	Retain for further evaluation.
Disposal						
Onsite Consolidation		Onsite consolidation of rubbelized concrete into a berm along north side of site.	Effective because of very limited mobility characteristics of PCBs.	Implementable though engineering characteristics of existing containment cells in area needs to be considered.	Low.	Retain for further evaluation.

TABLE 3-1
Remedial Technology Screening–Building Materials
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Landfill	TSCA Landfill	Solid wastes with PCBs greater than 50 mg/kg or 100 μg/100 cm^2 are permanently disposed of in a TSCA permitted landfill.		Technology is commercially available at a full scale for the COCs at OMC.		Retained for further evaluation.
	Non-RCRA Landfill	Solid nonhazardous wastes are permanently disposed of in a Subtitle D landfill.		Technology is commercially available at a full scale for the COCs at OMC.		Retained for further evaluation.

Note:
COC = Contaminant of concern
BCD = Base-catalyzed dechlorination
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.

Potentially feasible technologies and options for each general response action for addressing the buildings at the site are shown in plain text (that is, background not shaded) in Table 3-1. The response actions and associated technologies retained following screening include the following:

- No further action
- Containment: capping of demolished building slab
- Removal and treatment: physical/chemical treatment and thermal treatment of metal
- Removal and disposal: onsite consolidation, offsite landfill

The rationale for selecting these process options is indicated in Table 3-1. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options.

3.4.2 Containment

Under the containment response, capping was selected because it is a relatively inexpensive option and would effectively prevent direct contact exposure and erosion. The method excludes capping of the building slab in-place because this method is not compatible with future site development. However, capping of the demolished building slab was retained as an option because demolition prior to capping would provide for consolidation of the material in a location appropriate to future site development.

3.4.3 Treatment

Physical/chemical treatment of porous and nonporous building materials would be conducted prior to demolition to remove PCBs to below regulatory concentrations to allow for less expensive disposal options. Demolition contractors familiar with PCB remediation would determine the cost-effectiveness of cleaning methods versus disposal costs. Building materials exceeding regulatory PCB criteria would be disposed offsite in a TSCA landfill. Metal could be recycled if it is not contaminated with PCBs or is decontaminated onsite. Contaminated metal can also be recycled in a smelter meeting TSCA requirements. This was also retained as a potentially viable technology.

The type of physical/chemical treatment would be determined either as part of design or would be determined by the demolition contractor. Onsite consolidation or offsite disposal in a Subtitle D landfill are viable technologies for concrete with PCBs less than 50 mg/kg. There are Subtitle D and TSCA landfills in Illinois and some adjoining states in relative proximity to the OMC site. Disposal was retained as an option because of the comparatively low cost and availability of disposal facilities. Recycling of concrete passing regulatory criteria is also potentially viable.

Thermal treatment of concrete with PCBs greater than 50 mg/kg was also considered. Thermal treatment uses heat to volatilize organic compounds and remove them. This technology is generally used with soil and would, therefore, require crushing the concrete material prior to treatment. This method would not be applicable to other building materials, such as structural steel, roofing, or siding. Additional pretreatment may be required to adjust the moisture content once concrete is crushed. Heat is applied through natural gas or other fuel combustion with direct heat transfer to the media in a rotary or asphalt kiln. (Indirect methods are less common.) Media is processed and fed to the thermal treatment device and the treated recycled concrete is then stockpiled and eventually backfilled at the site.

High-temperature thermal desorption is capital intensive and requires multiples steps. In addition, air emission control would be necessary. The system air emission controls would include a cyclone particulate removal device for emissions exiting the kiln to protect the baghouse used for fines removal. Following the baghouse, the air emissions would be treated in a natural gas-fired incinerator (afterburner) to oxidize the desorbed organics. Air emission controls can add significant cost to the method because of the treatment required to remove dioxins and furans.

In incineration, high temperatures are used to volatilize and combust halogenated and other refractory organics (1,400 to 2,200 degrees Fahrenheit [°F]). Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is applicable to a wider range of material than thermal treatment in that it oxidizes bulk quantities of waste that may be in liquid and solid phase.

There are only three incinerators in the United States that hold a TSCA permit to incinerate PCB-contaminated materials. These facilities are located in Texas and Utah. Transportation of the contaminated media to these facilities would be required for offsite incineration, which would result in a relatively high transportation cost compared to other alternatives.

Thermal treatment or incineration may be cost competitive when compared to offsite disposal of material at a TSCA landfill. However, while thermal treatment may be applicable to crushed concrete, there is a relatively low volume of concrete that would be required for disposal at a TSCA landfill. This method was not retained for further consideration because of the resulting high overall relative cost compared to offsite disposal.

3.5 Technology and Process Option Screening for Soil and Sediment

Table 3-2 presents a wide range of potentially applicable technology types and process options for soil and sediment remediation at the site. The screening is combined for soil and sediment because the media presents similar characteristics in depth and degree of contamination.

The response actions and associated technologies retained following screening including:

- No further action
- Institutional controls: deed restrictions and permits
- Excavation of the soil and sediment
- Removal and disposal: onsite consolidation, disposal offsite (TSCA or Subtitle D landfills)

The rationale for selecting these process options is indicated in Table 3-2. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These include evaluation of containment in-place and ex situ chemical treatment (chemical extraction, Sonoprocess™) or thermal treatment (high-temperature thermal desorption, incineration).

3.5.1 Containment

As shown in Table 3-2, covering or capping the PCB- and PAH-contaminated soils in-place was not considered a viable technology because the site is intended for future residential development, and the soil and sediment contamination is relatively shallow, limited in extent, and can be cost-effectively removed.

3.5.2 Chemical Extraction Treatment

Chemical extraction is a process where soil and a solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed into a separator, where the COCs and solvent are separated for treatment and further use or disposal. One advantage of chemical extraction is the reduction of waste; however, chemical extraction does not destroy wastes. The COCs extracted from the soil or sediment typically require another step in treatment or disposal.

Sonoprocess™ is a proprietary process specifically targeted for the chemical destruction of PCBs. The soil or sediment is mixed with water to create slurry. The reagents and slurry are pumped through a sonic reaction chamber. The reagent dechlorinates the PCBs to leave nontoxic benzene molecules. The solvent is recycled by washing and filtering until disposal as an industrial fuel.

If solvent extraction is used for PCBs and other chlorinated compounds, concentrations of these contaminants in the solvent must be kept very low if the resulting solvent is going to be burned. Burning may cause the formation and release of dioxins and furans. If acid extraction is used, the acid needs to be neutralized in the treated soil or sediment.

Chemical extraction is capital intensive and requires multiple steps. The soil would require excavation, material separation/sieving, premixing, separation, possible post-treatment, and disposal onsite (soil/sediment) and disposal offsite (byproducts). Several pieces of equipment and a large working area are required to process the soil, resulting in high mobilization and demobilization costs. These costs are more readily justified when large volumes of soil and high contaminant concentrations are slated for treatment because the economy of this method is recognized when larger volumes do not require transportation and disposal offsite. Considering the relatively low volume of soil and sediment and relatively low concentrations of contaminants in the soil at the OMC site, the chemical extraction technologies were not retained for further consideration because of the relatively higher overall cost.

3.5.3 Thermal Desorption and Incineration

Thermal treatment uses heat to volatilize organic compounds and remove them from the soil. Heat is applied through natural gas or other fuel combustion with direct heat transfer to the soil media in a rotary or asphalt kiln. (Indirect methods are less common.) Excavated soil or sediment is processed and fed to the thermal treatment device and the treated soil is then stockpiled and eventually backfilled at the site.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
No Action						
None	None	No further actions to address soils exceeding PRGs.	None.	Implementable.	None	Required for comparison.
Institutional Controls						
Access and Use Restrictions	Deed restrictions	Deed restrictions issued for property within potentially impacted areas to restrict property use.	Poor if used alone since exposures to surface soil are not controllable with restrictive covenants alone. Effective for controlling access to subsurface soil.	Implementable.	Low	Retained for use only in conjunction with other technologies. Not retained as a sole technology because area is intended to be redeveloped as residential.
	Fences	Security fences installed around potentially impacted areas to limit access.	Good.	Good.	Low	Not retained. Fencing to prevent access is not compatible with future site development.
	Permits	Regulations promulgated to require a permit for excavation/removal activities.	Not applicable to surface soil contamination. May be effective in controlling subsurface excavation into contaminated soil and disposal of excavated contaminated soil.	May be difficult to implement for individual parcels.	Low	Retained. Permits for subsurface excavation could be used as a means to provide notification for potential subsurface contamination and proper disposal of contaminated subsurface soil.
Containment						
Capping	Native soil cover	Soil exceeding PRGs covered with uncontaminated native soil and revegetated to prevent direct contact and erosion. Control of leaching is not essential because PCBs and PAHs onsite in soil have limited mobility.	Effective if future site development does not result in placement of contaminated soil from below the cover.	Easily implemented.	Covers are generally the least expensive way to manage the human health and ecological risks effectively.	Not retained. A native soil cover may not be effective in the long-term in the dune area. Onsite the soil exceeding PRGs is relatively shallow and can be cost-effectively excavated eliminating the need for long-term management below a residential development.
	Clay cap, synthetic membranes, sealants, asphalt, concrete	Soil exceeding PRGs capped with any one of a variety of low permeability cap materials to prevent direct contact, erosion and leaching.	Effective if future site development does not result in excavation through the cap.	Easily implemented but precludes future site development because the integrity of the cap would be compromised by the subsurface building foundations and utilities.	Caps are generally a low cost method to manage the human health and ecological risks effectively.	Not retained. A cap over the soil exceeding PRGs would prevent future site development. Not retained for sediment because cap is subject to future erosion.
Surface Controls		Surface controls used to reroute surface water around contamination or otherwise control erosion.	Surface controls are generally not effective alone but must be used with covers or caps.	Easily implemented.	Low	Not retained. Surface controls alone are not compatible with future site development.
In Situ Treatment						
Biological	Enhanced aerobic bioremediation	Injection of water containing inducers and electron acceptor (oxygen) to enhance aerobic biodegradation. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass.	Bioremediation is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration. An infiltration gallery or spray irrigation is typically used for shallow impacted soils, and injection wells are used for deeper impacted soils.	Typical costs for enhanced bioremediation range from \$20 to \$80 per cubic yard of soil. Variables affecting the cost are the nature and depth of the COCs and use of bioaugmentation.	Not retained. Not well suited for contaminants of concern and concentrations in the soils which are found onsite.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Enhanced anaerobic bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, dinitrogen gas is ultimately produced.	Bioremediation is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration. An infiltration gallery or spray irrigation is typically used for shallow impacted soils, and injection wells are used for deeper impacted soils.	Typical costs for enhanced bioremediation range from $20 to $80 per cubic yard of soil. Variables affecting the cost are the nature and depth of the COCs and use of bioaugmentation.	Not retained. Not well suited for contaminants of concern and concentrations in the soils which are found onsite.
	Bioventing	Oxygen is delivered to impacted unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. Bioventing uses low airflow rates to provide only enough oxygen to sustain microbial activity.	Bioventing is not effective for treating PCBs in situ.	Difficult to implement for shallow contaminated soils of relatively low concentration.	Moderate costs. Costs for operating a bioventing system typically are $10 to $50 per cubic yard. Factors that affect the cost of bioventing include contaminant type and concentration, soil permeability, well spacing and number, pumping rate, and off-gas treatment.	Not retained. Not well suited for contaminants of concern in the soil and hydrogeology which is found onsite.
	Natural attenuation	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Generally, the lowest cost alternatives were applicable.	Not retained. Not effective for PCBs.
	Land treatment	Impacted surface soil is treated in place by tilling to achieve aeration, and if necessary, by addition of amendments. Periodically tilling, to aerate the waste, enhances the biological activity.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Moderate costs: $25 to $50 per cubic yard.	Not retained due to limited effectiveness on PCBs.
	In situ soil mixing (ISESM)	Use of large-diameter augers to physically disturb the subsurface, with the introduction of hot air, steam, peroxide, or other fluids to promote contaminant removal or destruction. Soil mixing can be combined with many variations such as vapor extraction and ambient air injection, vapor extraction and hot air injection, hydrogen peroxide injection, ZVI injection and grout injection for solidification/stabilization.	SSM with injection of an oxidant may be effective for treatment of PCBs and PAHs though bench and pilot testing would be needed.	Implementable.	High cost when the SSM is combined with in situ oxidation.	Not retained. Not cost effective for relatively low concentrations and broad shallow contamination found onsite.
	Phytoremediation	Use of plants and their associated rhizospheric microorganisms to remove, transfer, stabilize, and/or destroy COCs in soil or groundwater.	The depth of the treatment zone is determined by root depth of the plants or trees used (e.g., Polar max depth 15 feet). Limited to shallow soils because roots must contact contamination. Effectiveness varies seasonally in Illinois climate.	Requires a large surface area for an extended period of time. High concentrations of hazardous materials can be toxic to plants. It is still in the demonstration stage and has not met widespread regulatory approval.	Low to moderate.	Not retained due to the plans for future site development and anticipated timeframe. Not applicable to sediments.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Physical-Chemical Treatment	Surfactant/Cosolvent flushing (soil flushing)	Delivery of a solution with wash-improving additive that enhances the physical displacement, solubilization, or desorption of COCs. Flushing solutions include plain water sometimes augmented by surfactants, cosolvents, or other facilitators.	Poor. PCBs and PAHs are difficult to solubilize and flush to extraction system. Potential exists for spreading of the contaminants to deeper soil zones.	Developing technology. Laboratory and field pilot studies must be performed under site-specific conditions before selected as the remedy. Requires greater understanding of the site's geology than some other technologies. Would require solution to be placed on the surface to impact depth of soil contamination.	Moderate to high, O&M intensive. Less cost-effective for organic materials. The treated water could be recycled for use in the flushing solution. Application necessitates extensive pre-design data collection and treatability studies. Generalized costs are approximately $75 to $210 per ton of impacted soil or estimated at $75-200 /cubic yard of impacted material.	Not retained. Poor effectiveness for PCBs and PAHs. Not well suited for shallow depth of soil contamination found onsite. Depth of COCs at the site is primarily limited to the first 2 feet of soil, so flushing would potentially transport COCs through currently uncontaminated, unsaturated soil.
	Solidification/ Stabilization (S/S)	COCs are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Auger/caisson systems and injector head systems are used to apply S/S agents to in situ soils.	PCBs are already of limited mobility in soil. Not applicable to in situ treatment of PCBs in sediment.	Solidification of shallow soils would limit ability of soils to support vegetation and render the soil unsuitable for certain structural loading or excavation. Not currently applicable to in situ treatment of sediments. Requires pilot testing to determine what, if any reagent is suitable.	O&M and capital intensive. Bench and pilot-scale testing likely required prior to field implementation. The in situ soil mixing/auger techniques average $40 to $60 per cubic yard for the shallow applications. The shallow soil mixing technique processes 40 to 80 tons per hour on average.	Not retained. Changes physical characteristics of soil such that future development may be hindered or prevented. Not applicable to sediments.
	Vitrification (ISV)	ISV is a process which uses an electric current to melt soil or other earthen materials at extremely high temperatures (1,600 to 2,000 °C or 2,900 to 3,650 °F) to form a glass and crystalline structure with very low leaching characteristics. The vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock.	PCBs are already of limited mobility in soil. Not applicable to in situ treatment of PCBs in sediment.	There have been few commercial applications of ISV. Application changes physical characteristics of soil and may render them unsuitable for some future uses, such as structural loading, excavation, and ability to support vegetation. Requires pilot testing.	Very high. For ISV, average costs for treatability tests for PCBs and dioxins is $30K plus analytical. Equipment mobilization and demobilization costs are $200K to $300K combined.	Not retained. Changes physical characteristics of soil such that future development may be hindered or prevented. Technology not readily available.
	Chemical oxidation/reduction	Oxidation/Reduction agents applied to impacted soil to reduce or oxidize COCs.	Organic content may reduce effectiveness and/or require additional volume of reagent. Not as effective for PCBs as for other organic compounds.	In situ process requires delivery of a reagent into the subsurface and direct contact with COCs. While surficial soils provide easy access to COCs, injection in shallow soils difficult to safely implement.	High. Estimated costs range from $150 to $500 per cubic yard.	Not retained due to the questionable effectiveness on PCBs and depth of COCs in soil.
Thermally Enhanced SVE	Electrical resistance heating/six phase soil heating/radio frequency heating/steam heating	Variety of heating methods to promote steam generation to vaporize target compounds. Vapors recovered in a SVE system and treated as needed to remove VOCs from air discharge.	Most technologies are in the development stage. Limited effectiveness on PCBs and shallow depth of COCs.	Implementable	High. Available data indicate the overall cost for thermally enhanced SVE systems is approximately $25 to $100 per cubic yard.	Not retained. SVE not a suitable technology for PCBs and depth of COCs.
Ex Situ Treatment						
Biological	Biopiles	Biopile treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Biopiles are relatively simple and require few personnel for operation and maintenance. Typical costs with a prepared bed and liner are $100 to $200 per cubic yard.	Not retained due to the questionable effectiveness on PCBs.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Composting	Impacted soil is excavated and mixed with bulking agents and proper organic amendments such as wood chips, hay, manure, and vegetative (e.g., potato) wastes to ensure adequate porosity and provide a balance of carbon and nitrogen to promote thermophilic, microbial activity.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Estimated costs for full-scale windrow composting of explosives-impacted soils are approximately $190 per cubic yard for soil volumes of approximately 20,000 yd3.	Not retained due to the questionable effectiveness on PCBs.
	Land farming	Impacted soil, sediment, or sludge is excavated mixed with soil amendments, applied into lined beds, and periodically turned over or tilled to aerate the waste. Usually incorporates liners and other methods to control leaching of COCs.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Unlikely to be approved by agencies due to limited effectiveness for PCBs.	Costs prior to treatment (assumed to be independent of volume to be treated): $25,000 to $50,000 for laboratory studies; $100,000 to $500,000 for pilot tests or field demonstrations. Cost of prepared bed (ex situ treatment and placement of soil on a prepared liner): Under $75 per cubic yard.	Not retained due to limited effectiveness on PCBs.
Physical/Chemical	Chemical oxidation/reduction	Oxidation/Reduction agents applied to impacted soil to reduce or oxidize COCs.	Organic content may reduce effectiveness and/or require additional volume of reagent. Not as effective for PCBs as for other organic compounds.		Estimated costs range from $150 to $500 per cubic yard.	Not retained due to the questionable effectiveness on PCBs.
	Reductive dehalogenation: based-catalyzed (BCD) or glycolate	Impacted soil is screened, processed with a crusher and pug mill, and mixed with NaOH and catalysts (BCD) or alkaline polyethylene glycol (APEG) reagent. The mixture is heated in a rotary reactor to dehalogenate and partially volatilize the contaminants or render them nonhazardous. Vapors from the heating process are collected and treated as needed.	Effective but is not typically applied to relatively low PCB concentrations because of high cost.	Transportable technology that can be brought onsite. The process employs off-the-shelf equipment and requires less time and space to mobilize, set up, and take down than an incinerator.	Very high. The cost for full-scale operation is estimated to be in a range of $200 to $500 per ton and does not include excavation, refilling, residue disposal, or analytical costs.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Separation	Separation techniques concentrate impacted solids through physical and chemical means. These processes seek to detach compounds from their medium (i.e., the soil, sand, and/or binding material that contains them).	May be effective but is not typically applied to relatively low PCB concentrations because of high cost.	Transportable technology that can be brought onsite. The process employs off-the-shelf equipment and requires less time and space to mobilize, set up, and take down than an incinerator.	Moderate to high.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Soil washing	COCs sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. Wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics. It does not destroy or immobilize the contaminants. Consequently, the resulting concentrated soil must be disposed of carefully.	Considered a transfer technology in that the contaminants are not destroyed, but transferred to another media. Varying concentrations and mix of COCs at the site creates a complex washing solution. There is a limited volume of soil and sediment greater than 50 mg/kg. Reduction to below 1 mg/kg may require multiple washings.	Pilot/bench scale testing would be required.	High. The average cost for use of this technology, including excavation, is approximately $170 per ton, depending on site specific conditions and the target waste quantity and concentration.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Solidification/ Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex situ S/S typically requires disposal of the resultant materials.	PCBs and PAHs are already of limited mobility in soil or in dewatered sediment.	Implementable although solidified soil and sediment could not be used to support vegetation.	Moderate. $40 to $60 per cubic yard.	Not retained. Solidification not needed for limited mobility constituents prior to disposal.
	Chemical extraction	Soil and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed in a separator, where the COCs and solvent are separated for treatment and further use.	Effective for high concentrations of PCBs. Less effective for relatively low concentrations found onsite. Considered a transfer technology in that the contaminants are not destroyed, but transferred to another media. There is a limited volume of soil and sediment greater than 50 mg/kg. Reduction to below 1 mg/kg may require multiple applications.	Commercial-scale units are in operation.	High. Capital costs can be relatively high, but technology can be cost effective for very high PCB concentrations and large volumes of soil and sediment. Cost estimates for this technology range from $100 to $400 per ton, depending on the volume of soil treated.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Sonoprocess	The sediment is slurried in hydrocarbon matrix. Free water is removed and the slurry readied for chemical destruction of the PCB. The reagents and slurry are pumped through a sonic reaction chamber. The reagent dechlorinates the PCB to leave non-toxic benzene molecules. The solvent is recycled by washing and filtering until disposal as an industrial fuel.	Effective though limited applications to date.	Technology is emerging. Proprietary process of a vendor.	High overall cost. Geared toward smaller quantities of highly contaminated soil.	Not retained. Not cost effective for relatively low concentrations found onsite.
Thermal	Thermal Desorption	Soils and sediments are heated in a chamber to high temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Very effective. Provides a physical separation of VOCs. Not designed to destroy organics. HTTD has been proven to remove greater than 99% of PCBs in contaminated soil.	Technology is commercially available.	High Capital and O&M cost because feed rate is constant and requires moving the soil before and after treatment. Rates vary from $40 to $300 per ton of soil. Also requires mob/demob of equipment.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
	Onsite Incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) PCBs and SVOCs.	Good.	There are few mobile incinerators commercially available to treat PCBs and dioxins.	Mobile units that can be operated on-site will reduce soil transportation costs. Soils impacted with PCBs or dioxins cost $1,500 to $6,000 per ton to incinerate. There are specific feed size and materials handling requirements that can impact applicability or cost at specific sites.	Not retained. A mobile incinerator is not cost effective for the limited volume and relatively low contaminant concentrations in the soil and sediment.

TABLE 3-2
Remedial Technology Screening–Soil and Sediment
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Offsite incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) PCBs and SVOCs.	Good.	Potential risk of transporting the hazardous waste. Three offsite incinerators in the U.S. permitted for PCBs.	Soil treatment costs at off-site incinerators range from $200 to $1,000 per ton of soil, including all project costs. Soils impacted with PCBs or dioxins cost $1,500 to $6,000 per ton to incinerate. There are specific feed size and materials handling requirements that can impact applicability or cost at specific sites.	Not retained. Not applicable to low concentration of PCBs found in onsite soil and sediment. Intended for heavily contaminated soil or sediment.
Removal						
Excavation	Excavation	Excavation of soil and sediment using ordinary construction equipment.	Very effective. Unsaturated soil within normal range of excavation equipment (0-8 feet). Very few obstructions to excavation at the site.	Good.	Moderate. Cost estimates for excavation and disposal range from $50 to $200 per ton, including excavation/removal, transportation, and disposal.	Retain for further evaluation.
Disposal						
Land Application	Land application	Soil and sediment placed on land so it can be degraded, transformed, or immobilized.	Poor. PCBs are very slow to biodegrade and would be present for decades. Carcinogenic PAHs are also slow to degrade in shallow soil.	Good.	Similar to excavation.	Not retained. Not effective for primary contaminants of concern SVOCs and PCBs found at the site.
Onsite Consolidation		Onsite consolidation of soil and dewatered sediment into a berm along north side of site.	Effective assuming soils and sediments are covered with clean soil and vegetated because of very limited mobility characteristics of PCBs and PAHs.	Implementable though engineering characteristics of existing containment cells in area needs to be considered.	Low.	Retain for further evaluation.
Landfill	TSCA or RCRA Subtitle C Landfill	Solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill.	Good.	There are suitable landfills within relative proximity of the site.	Moderate to high. Variable but typically exceed $50/ton.	Retained for further evaluation.
	Subtitle D Solid Waste Landfill	Solid nonhazardous wastes are permanently disposed of in a non-RCRA landfill.	Good.	There are suitable landfills within relative proximity of the site.	Moderate. Disposal costs typically range from $20 to $50/ ton.	Retained for further evaluation.

Note:
COC = contaminant of concern
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.

Similar to chemical extraction methods, high-temperature thermal desorption is capital intensive and requires multiples steps (although fewer steps than chemical extraction). In addition, air emission control would be necessary. The system air emission controls would include a cyclone particulate removal device for emissions exiting the kiln to protect the baghouse used for fines removal. Following the baghouse, the air emissions would be treated in a natural gas-fired incinerator (afterburner) to oxidize the desorbed organics. Air emission controls can add significant cost to the method because of the treatment required to remove dioxins and furans.

In incineration, high temperatures are used to volatilize and combust halogenated and other refractory organics (1,400 to 2,200°F). Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is different from other thermal technologies in that it oxidizes bulk quantities of waste that may be in liquid and solid phase. Incineration is used to remediate soils and sediments impacted with, among other constituents, chlorinated hydrocarbons, PCBs, and dioxins.

There are only three incinerators in the U.S. that hold a TSCA permit to incinerate PCB-contaminated materials. These facilities are located in Texas and Utah. Transportation of the contaminated soil and sediment to these facilities would be required for offsite incineration, which would result in a relatively high transportation cost compared to other alternatives.

Considering the relatively low volume of soil and relatively low concentrations of contaminants in the soil at the OMC site, thermal treatment was not retained for further consideration because of the air emission requirements and resulting high overall cost.

3.5.4 Disposal

One process option selected for disposal of untreated excavated soils and sediments at the site is containment under the soil cover o onsite in a berm along the northern site boundary. PCB soils and sediments exceeding 50 mg/kg will be disposed offsite at an approved TSCA landfill.

The other process option is offsite disposal of all excavated soil and sediment above PRGs. Material less than 50 mg/kg PCBs would be disposed in a Subtitle D landfill, while other material equal to or exceeding 50 mg/kg will be disposed offsite at an approved TSCA landfill. Offsite disposal at a landfill would involve excavation and transportation of the soil and sediment to an appropriately permitted facility. There are Subtitle D and Subtitle C landfills in Illinois and some adjoining states in relative proximity to the OMC site.

Disposal was retained as an option because of the comparatively low cost, availability of disposal facilities, and relatively low concentrations of contaminants at the site.

3.6 Technology and Process Option Screening for DNAPL

Using the same methodology described in the preceding sections, Table 3-3 presents the screening of technology types and process options available for remediation of DNAPL. Potentially feasible technologies and process options for each general response action for remediation of DNAPL at the OMC site include the following:

- No further action
- Institutional controls: deed restrictions, permits, and monitoring
- In situ treatment: chemical reduction, electrical resistance heating, and thermal desorption
- Collection: vertical wells, horizontal wells
- Excavation of DNAPL soils
- Offsite incineration of collected DNAPL and DNAPL soil

The rationale for selecting these process options is indicated in Table 3-3. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These include the in situ treatment, DNAPL collection, and excavation, technology process options.

3.6.1 In Situ Treatment

Remedial technologies evaluated as part of the in situ response action for DNAPL at the OMC site are summarized below.

Chemical Reduction

Amendments such as emulsified zero valent iron (ZVI) or bentonite with ZVI are delivered into the DNAPL area using soil mixing methods. Soil mixing allows for treatment of the DNAPL in situ and/or stabilizes the DNAPL to limit the potential for future migration. The ZVI component will also treat the dissolved phase in the immediate area of the DNAPL to reduce the potential for a dissolved phase contaminant plume.

Soil mixing is also effective for residual DNAPL. Because residual DNAPL does not flow and cannot be removed by pumping, soil mixing effectively distributes the treatment amendments throughout the residual DNAPL zone. The cost of soil mixing is moderate due to the specialized equipment required to mix soil at a depth of 30 feet bgs and is primarily affected by the volume of the DNAPL area.

Thermal Treatment

In situ thermal treatment remedial technologies include two process options, electrical resistance heating (ERH) and in situ thermal desorption.

Electrical Resistance Heating. Resistance heating generates physical conditions in the subsurface that enhance the release of contaminants from the subsurface. Heat is generated by installing electrodes into the subsurface and passing a current between the electrodes. The natural resistance of the soil results in subsurface heating. The heated contaminants are then collected near the ground surface as steam or extracted by pumping. The steam is condensed while VOCs remain primarily in the vapor phase are treated and released. The cost of electrical resistance heating is moderate to high and is primarily affected by the volume of the area to be treated and the inflow of cold water from the aquifer extending the time to heat the treatment area to the target temperature.

TABLE 3-3
Remedial Technology Screening–Groundwater and DNAPL
OMC Plant 2 FS

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
No Action						
None	None	No action.	None.	Implementable.	Zero.	Required for comparison.
Institutional Controls						
Access and Use Restrictions	Deed restrictions	Deed restrictions issued for property, source area, and/or downgradient groundwater exceeding the clean up goals to restrict groundwater and land use.	Good.	Good.	Low.	Retained. Needed to ensure groundwater is not used until PRGs are attained.
	Permits	Regulations promulgated to require a permit for various activities (i.e., installation of wells, etc.).	Good.	Good.	Low.	Retained.
Alternative Water Supply		Variety of alternate water supply methods used to replace contaminated water supply. Not applicable to OMC site because there are currently no water wells that could be impacted by the site.	Good.	Good.	Moderate capital cost and high O&M	Not applicable. Potable water is already supplied by the city.
Monitoring		Short-and/or long-term routine monitoring is implemented to record site conditions, concentration levels, and natural attenuation parameters.				Critical to monitor effectiveness of any action.
Containment						
Vertical Barriers	Slurry walls	Trench around impacted area is excavated and filled with a slurry of low permeability material to provide a barrier.	Very effective for sites where containment of contaminant plumes threatening downgradient receptors is the primary remedial objective. At OMC the primary objective is to return groundwater to meet the PRGs. Downgradient migration is very slow and the plume is not discharging to the harbor or lake. As a result, containment technologies for groundwater do not meet the remedial objectives.	Slurry walls are typically placed at depths up to 100 feet and are generally 2 to 4 feet in thickness. Installation depths over 100 feet are implementable using clam shell bucket excavation, but the cost per unit area of wall increases by about a factor of three. Slurry walls have been used for decades, so the equipment and methodology are readily available and well known; however, the process of designing the proper mix of wall materials to contain specific contaminants is less well developed.	Moderate - Costs escalate with depth. Costs likely to be incurred in the design and installation of a standard soil-bentonite wall in soft to medium soil range from $6 to $8 per square foot. These costs do not include variable costs required for chemical analyses, feasibility, or compatibility testing. Testing costs depend heavily on site-specific factors.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs. Slurry walls are not applicable to temporary containment needed for DNAPL excavation alternative.
	Vibrating beam	Vibratory force used to advance steel beam into the ground. A relatively thin wall of cement or bentonite is injected as the beam is withdrawn.	Continuity of wall is difficult to assess and leakage may occur.	Good, shallow depth to confining unit reduces potential for complications.	High. High capital costs for installation equipment.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	Grout curtains	Grout pressure injected along contamination boundaries in a regular overlapping pattern of drilled holes.	Continuity of wall is difficult to assess and leakage may occur.	Good, shallow depth to confining unit reduces potential for complications.	Moderate.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.

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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Sheet piling	Interlocking steel piles are driven into subsurface along the boundaries of the impacted area. Sheet piling would be used as temporary shoring for DNAPL excavation.	Very effective for temporary shoring of soil during excavation.	Implementable to depths of about 30 feet needed at site.	Moderate.	Not retained for containment of groundwater. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs. Retained as a component of DNAPL excavation alternative to provide temporary shoring of excavation sidewalls for small areas.
	Permeability reduction agents	Cement grout or organic polymer injected into the soil matrix to reduce permeability.	Experimental process option.	Good in the shallow portion of the aquifer and moderate in the low portion of the aquifer where permeability is reduced.	Moderate.	Not retained for containment of groundwater. At OMC containment technologies for groundwater do not meet the primary objective to return groundwater to meet PRGs. Retained as a component for DNAPL treatment.
	Ground freezing (cryocell process)	Ground freezing technology is used to form a flow-impervious, removable, and fully monitored ice barrier that circumscribes the contaminant source in situ	Short-term effectiveness has been reported.	Requires piping installation, limited inflow of warm water, low groundwater velocity is best	High. High capital costs and high O&M costs.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
Horizontal Barriers	Block displacement	Controlled injection of slurry in notched injection holes produces a horizontal barrier beneath contamination.	Experimental process option.	Moderate.	High.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	Grout injection	Grout pressure injected at depth through closely spaced drilled holes.	Effective for small areas.	Good.	Moderate. Equipment intensive.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	Ground freezing	Similar to vertical barriers by ground freezing.	Experimental process option.	Moderate.	High.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	Liners	Liners placed to restrict vertical flow can be constructed of the same materials considered for cap construction.		Poor.	Moderate.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
Hydraulic	Vertical wells	Conventional groundwater extraction is pumping in vertical wells. Other extraction device include vacuum enhanced recovery, jet-pumping systems, etc.	Widely used and demonstrated effectiveness. Generally effective for hydraulic containment (i.e., horizontal migration) and ineffective for groundwater restoration.	Good. Common technology; often combined with other treatment technologies applied to the extracted groundwater in an integrated system.	Considered moderately cost-effective; good cost-effectiveness at lower permeability sites.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	Horizontal wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Widely used and demonstrated effectiveness. Increasingly applied technology for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Requires sufficient area at one end of well for equipment and angled penetration. Often combined with other treatment technologies applied to the extracted groundwater in an integrated system	Significantly higher than vertical wells.	Not retained. At OMC containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.

TABLE 3-3
Remedial Technology Screening–Groundwater and DNAPL
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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect groundwater.	Drains are not suited to high permeability formations where extraction wells are more effective.	Requires sufficient area and access. Often combined with other treatment technologies applied to the extracted groundwater in an integrated system	Low to Moderate depending on depth to groundwater. May require long piping runs to transfer collected groundwater to treatment system or discharge point.	Not retained. Containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
	One-pass trenching	Trenches backfilled with granular material provide preferred flow path for collection in pipe or sump. Groundwater collection technique to increase production rate from low permeability areas.	Widely used and demonstrated effectiveness. Effective for increasing groundwater production rate from low permeability areas. Used where aquifer is heterogeneous.	One-pass trenching limited to depths of 25 feet or less. Requires absence/removal of obstacles (e.g. utilities) along trench alignment.	Where implementable, less costly than traditional trenching methods (except small sites). Trenches are excessively costly in bedrock.	Not retained. Containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
In Situ Treatment						
Chemical	Chemical oxidation (ISCO)	Aqueous injection of oxidizing agents (peroxide/iron, permanganate, persulfate, or ozone) to promote abiotic in situ oxidation of chlorinated organic compounds.	Effective, requires good contact between target contaminant and reagent.	Commercially available. Moderate health and safety concerns depending on oxidant selected. High organic content in some groundwater samples would reduce efficiency.	Moderate to high. More costly than reductive processes because anaerobic groundwater would require much higher oxidant dosage to overcome the reducing environment. Oxidation is also not cost-effective for low-concentration dissolved VOC plumes.	Not retained. Anaerobic reductive dechlorination processes are more suitable to the present reducing environment in groundwater.
	Chemical reduction (ISCR)	Aqueous injection of reducing agents (zero valent iron, bioavailable carbon, hydrogen) to promote abiotic in situ reduction of chlorinated organic compounds.	Effective in treating site COCs. Most suitable as a source area treatment for high concentration groundwater.	Well developed technology with minimal equipment requirements.	Considered to have good potential for cost-effectiveness for source zones but is costly for low concentration plumes.	Retained for further evaluation in DNAPL and source areas.
	Permeable reactive barriers (passive treatment walls)	Permeable treatment units are installed across the flow path of impacted groundwater. As groundwater moves through the treatment wall, COCs are passively removed in the treatment zones by chemical and/or biological processes.	Very effective for sites where containment of contaminant plumes threatening downgradient receptors is the primary remedial objective. At OMC the primary objective is to return groundwater to meet the PRGs. Downgradient migration is very slow and the plume is not discharging to the harbor or lake. As a result, containment technologies for groundwater do not meet the remedial objectives.	Easily implementable at depths of 30 feet or less.	Moderate to high. Where applicable, considered a cost-effective alternative to conventional remedial action technologies.	Not retained. Containment technologies for groundwater do not meet the primary remedial objective to return groundwater to meet PRGs.
Physical	In-well air stripping (circulating Wells)	Groundwater is aerated and lifted within a well bore, re-infiltrates through a different strata of the formation, and creates groundwater circulation. Two systems would be needed because there is substantial difference between the shallow and deep aquifer permeability.	Effectiveness is affected by poor development of circulation zones due to heterogeneities in aquifer permeability. Typically, in-well air stripping systems are a cost-effective approach for remediating VOC-contaminated ground water at sites with deep water tables because the water does not need to be brought to the surface. Operate more efficiently with horizontal conductivities greater that 10^{-3} cm/sec and a ratio of horizontal to vertical conductivities between 3 and 10. A ratio of less than 3 indicates short circulation times and a small radius of influence. If the ratio is greater that 10, the circulation time may be unacceptably long.	Requires close well spacing, high iron concentrations may result in fouling.	Moderate to high. Extensive system capital investment required relative to alternatives.	Not retained due to the potential for well screen clogging and the need for separate shallow and deep systems as a result of the differing permeability.

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Remedial Technology Screening–Groundwater and DNAPL
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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Air sparging	Air is injected into saturated media to remove COCs through volatilization. May also be used at lower air flow rates to promote biodegradation of petroleum VOCs. Often coupled with SVE for collection/treatment of displaced VOCs.	Effective with tight well spacing (about 25 feet) in permeable, homogeneous media; significantly less effective in low permeability soils or stratified soils. Favors large saturated thickness and depth to groundwater (greater than 5 feet). Methane can be used as an amendment to the sparged air to enhance cometabolism of chlorinated organics.	Requires close well spacing, high iron concentrations may result in fouling.	Low to moderate. Generally considered cost-effective where applicable.	Not retained due to the presence of NAPLs at the site. Also the shallow groundwater table makes the technology impractical. Unknown piping networks beneath the building may cause migration of vapors.
	Dual phase extraction (DPE)	DPE is a technology that uses a high vacuum system to remove liquid (i.e., NAPL, contaminated groundwater) and soil vapor. The main purpose of the system is to lower the water table using high vacuum or groundwater pumping to expose the aquifer matrix to more rapid remediation via soil vapor extraction. Once above ground, the extracted vapors, liquid-phase organics, and/or groundwater are separated and treated.	Combination with complementary technologies (e.g., pump-and-treat) may be required to recover ground water from high-yielding aquifers. Use of DPE with these technologies can shorten the cleanup time at a site, as the capillary fringe is often the most contaminated area.	DPE is a full-scale technology and commercially available.	Moderate. Because of the number of variances involved, establishing general costs for dual phase extraction is difficult. Estimated cost are about $50 to $100 per cubic yard.	Not retained due to difficulty in dewatering the relatively permeable aquifer.
	Bioslurping	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils. Vacuum-enhanced free-product recovery extracts LNAPLs from the capillary fringe and the water table.	Bioslurping is not applicable at sites such as OMC without LNAPL or aerobically biodegradble COCs.	Presence of subsurface piping may result in short-circuiting of system.	Low to moderate.	Not retained due to absence of LNAPL and presence of COCs that are not amenable to aerobic degradation.
	Pneumatic fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor and fluid extraction technologies. The fracturing extends and enlarges existing fissures and introduces new fractures, primarily in the horizontal direction.	Effective in low permeability aquifers to increase permeability. Fracturing is an enhancement technology designed to increase the efficiency of other in situ technologies in difficult soil conditions. Tests results indicate that PF has increased the effective vacuum radius of influence nearly threefold and increased the rate of mass removal up to 25 times over the rates measured using conventional extraction technologies. In addition, numerous bench-scale and theoretical studies have been published.	Fracturing is widely used in the petroleum and water-well construction industries and is commercially available for remediation activities.	Moderate. Equipment intensive.	Not retained because aquifer already has sufficient permeability.
	Hydraulic fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize COC travel time via diffusion. Complements vapor or fluid extraction technologies.	Effective in low permeability aquifers to increase permeability. Fracturing is an enhancement technology designed to increase the efficiency of other in situ technologies in difficult soil conditions.	Fracturing is widely used in the petroleum and water-well construction industries. It is commercially available for use in hazardous waste remediation.	Moderate. The cost per fracture is estimated to be $1,000 to $1,500, based on creating four to six fractures per day.	Not retained because aquifer already has sufficient permeability.

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Remedial Technology Screening–Groundwater and DNAPL
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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Hot water or steam flushing/stripping (i.e., hydrous pyrolysis/ oxidation [HPO])	Steam is forced into an aquifer through injection wells. Vaporized components rise to the unsaturated zone, where they are removed by vacuum extraction and treated.	Increases the rate of VOC removal. The process is applicable to shallow and deep contaminated areas and readily available mobile equipment can be used.	Implementable though vapor recovery may be difficult due to thin unsaturated zone and presence of piping network below building.	Very high due to heating equipment and power requirements.	Not retained due to extensive subsurface piping network beneath building.
	Electrical resistance heating (ERH)	ERH is an electrical resistance heating technology that delivers separate electric phases through electrodes placed in a circle around a soil vent, which promotes in situ generation of steam to vaporize target compounds. Vapors recovered in a SVE system and treated as needed to remove VOCs from air discharge.	Effective for treatment of VOCs in shallow soils.	Implementable. Requires soils remain moist to ensure effective transfer of electricity and heat to aquifer.	High, power consumption costs vary.	Retained for further evaluation in DNAPL and source areas.
	In situ thermal desorption (ISTD)	The aquifer is heated in situ with heating elements. The heating results in vaporization of water and constituents for collection by a heated vapor extraction well.	Effective for treatment of VOCs and SVOCs in soils and groundwater with low gradients.	Implementable. Requires accurate conceptual model to ensure heating elements are installed below contamination, vapor migration outside of collection area is a concern, potential to mobilize DNAPL.	High capital and O&M costs for equipment and power. If NAPL is recovered disposal and treatment costs increase.	Retained for further evaluation in DNAPL and source areas.
	Dynamic underground stripping (DUS)	A combination of in situ steam injection, electrical resistance heating and fluid extraction to enhance contaminant removal from the subsurface. Similar to enhanced soil vapor extraction, except that it also treats groundwater contamination.	DUS has been effectively used for high concentration source areas. High cost makes it unsuitable to low concentration dissolved phase contamination.	Implementable. Treated soils can remain at elevated temperatures for years after cleanup stimulating re-growth of biological community. Soil venting can accelerate the cooling process. DUS/HPO is being field tested at several sites. Additional data on long-term routine operating experience with DUS/HPO is needed to better plan future applications	Very high costs due to relatively extensive capital system requirements, but becomes more cost-effective in larger applications.	Not retained due to more cost effective options available for site contaminants.
Biological	Enhanced reductive dechlorination	Subsurface delivery of electron donors hydrogen, lactate, food-grade oils, corn syrup, etc. within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Very effective when used to enhance existing anaerobic conditions for remediation of CVOCs. Typically applied to high concentration source areas rather than low dissolved phase groundwater contamination.	Implementable. Site-specific bench and/or pilot-scale testing recommended, relies on advective transport of amendments.	Low to Moderate. Will in many cases be more cost-effective than aerobic process since maintenance of aerobic conditions is not required.	Retained for further evaluation for groundwater.
	Natural attenuation	Short- and/or long-term routine monitoring is implemented to record site conditions, concentration levels, and natural attenuation parameters. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce concentrations to acceptable levels.	Good. Demonstrated to be occurring at the OMC site. Less generation or transfer of remediation wastes. Less intrusive as few surface structures are required. May be applied to all or part of a given site, depending on site conditions and cleanup objectives. Natural attenuation may be used in conjunction with, or as a follow-up to, other (active) remedial measures. Overall cost will likely be lower than active remediation. Longer time frames may be required to achieve remediation objectives, compared to active remediation.	Good regulatory agency acceptance.	Generally, the lowest cost alternative was applicable. The most significant costs associated with natural attenuation are most often due to monitoring requirements.	Retained for further evaluation for groundwater.

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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Phytoremediation	Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in ground water, surface water, and leachate. These mechanisms include enhanced rhizosphere biodegradation, hydraulic control, phyto-degradation and phyto-volatilization.	Not effective for remediating groundwater to depths of 30 feet bgs as is needed at OMC.	Most applicable for control of shallow groundwater plumes. High concentrations of hazardous materials can be toxic to plants.	Low to moderate. Where applicable, considered one of the most cost-effective options available. Construction estimates for phytoremediation are $200K/acre and $20K/acre for operations and maintenance	Not retained due to ineffectiveness in treating groundwater to depths of 30 feet as needed at OMC.
Collection						
Hydraulic	Vertical wells	Conventional groundwater extraction is pumping in vertical wells. Other extraction device include vacuum enhanced recovery, jet-pumping systems, etc.	Widely used and demonstrated effectiveness.	Implementable.	Low. Least cost groundwater extraction tech technology.	Retained for further evaluation for DNAPL and groundwater.
	Horizontal wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Widely used and demonstrated effectiveness. Increasingly applied technology for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Implementable.	Moderate. Significantly higher than vertical wells.	Retained for further evaluation as a component/enhancement of other alternatives for areas beneath the building or in DNAPL area.
	Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect groundwater.	Although they may be effective, drains are not suited to high permeability formations where extraction wells are more effective.	Implementable.	Moderate to high. May require long piping runs to transfer collected groundwater to treatment system or discharge point.	Not retained. Groundwater is more effectively removed from the high permeability aquifer materials using vertical wells.
Removal						
Excavation	Excavation	Excavation of DNAPL impacted soils can use ordinary construction equipment backhoes, bulldozers, and front-end loaders. Excavation of DNAPl soils at depths of 30 feet would require steel sheet piling for stabilizing the excavation walls.	Very effective because limits of contamination can be observed during excavation.	Excavation combined with offsite treatment and disposal of DNAPL soil is well proven and readily implementable technology.	High costs for deep excavation.	Not retained. Shoring required for excavation and dewatering would be cost prohibitive.
Ex Situ Treatment						
Chemical	Chemical oxidation (e.g., ultraviolet [UV] oxidation)	Oxidizing agents are used to destroy organic contaminants in an ex situ reactor. Potential oxidizing agents are UV radiation, ozone, and/or hydrogen peroxide/ferrous iron, or permanganate.	Proven effectiveness for most CVOCs. Oxidant selection critical as not all oxidants are equally effective on all compounds.	Good. Treatability testing necessary. No residual to regenerate. No VOC air emissions.	High.	Retained for further evaluation for groundwater.
	Solar detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight. Contaminants are mixed with a semiconductor catalyst such (e.g., titanium dioxide), and fed through a reactor which is illuminated by sunlight. Ultraviolet light activates the catalyst, which results in the formation of reactive chemicals known as "radicals." These radicals are powerful oxidizers that break down the contaminants into non-toxic byproducts such as carbon dioxide and water.	Poor effectiveness for site COCs. would require very large shallow ponds to allow photolysis but most losses would be via volatilization. Could not be operated during winter months.	The technology has been field tested, limited sunlight in this area of the country reduces practicality of this technology.	High.	Not retained due to poor effectiveness and operational constraints.

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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Chemical reduction	Reducing agents (zero valent iron) are used to destroy organic contaminants in an ex situ reactor. For example, CVOCs are reduced to carbon dioxide and water.	Effective for treating site COCs though treatment bed would be very large and costly at the high anticipated flow rates extracted from the aquifer.	Long contact time between reducing agent and groundwater may be required.	Moderate, cost dependent on reducing agent selected and life of reducing agent.	Not retained because other more cost-effective technologies such as air stripping and UV/oxidation are available.
	Precipitation	This process transforms dissolved compounds into an insoluble solid, facilitating the compound's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation. It is used as a pretreatment process with other technologies (such as chemical oxidation or air stripping), where the presence of metals would interfere with treatment.	Effective in treating metals. Not applicable to site COCs.	Implementable. Commonly applied technology.	Moderate to high. The primary capital cost factor is design flow rate. Capital costs for 20-gpm and 65-gpm packaged metals precipitation systems are approximately $85,000 and $115,000, respectively. Operating costs (excluding sludge disposal) are typically in a range from $0.30 to $0.70 per 1,000 gallon of ground water containing up to 100 mg/L of metals.	Not retained because it is not applicable to site contaminants.
	Ion exchange	Ion exchange removes ions from the aqueous phase by the exchange of cations or anions between the contaminants and the exchange medium. Ion exchange materials may consist of resins made from synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. They also may be inorganic and natural polymeric materials. After the resin capacity has been exhausted, resins can be regenerated for re-use.	Does not work well for mixed organic contaminants.	This technology has long been used in industry and is commercially available.	The cost for a typical ion exchange system ranges from $0.30 to $0.80 per 1,000 gallons treated. Key cost factors include pretreatment requirements, discharge requirements and resin utilization, and regenerant used and efficiency.	Not retained because it is not applicable to site contaminants.
	Hydrolysis	Destruction of contaminant through hydrolytic breakage of chemical bonds at elevated pH and high temperatures to aid in the breakage of chemical bonds	Requires excessively high temperatures to aid in the breakage of chemical bonds.	Moderate, treatment rates impact O&M requirements.	High, Requires high volumes of pH amendments or high energy inputs to raise temperatures.	Not retained due to limited effectiveness on CVOCs.
	Electrochemical reduction	Electrochemical treatment changes the oxidation state of ions in solution to a preferred and treatable state through the application of an electrolyte solution.	Effective for appropriate contaminants.	Moderate for low flow rates, high flow rates may require additional or larger electrodes.	High	Not retained because it is not applicable to site contaminants.
Physical Treatment	Separation	Separation processes seek to detach contaminants from their medium (i.e., ground water and/or binding material that contain them). Ex situ separation of waste stream can be performed by many processes: (1) distillation, (2) filtration/ ultrafiltration/ microfiltration, (3) freeze crystallization, (4) membrane evaporation, and (5) reverse osmosis.	Moderate.	Moderate.	High. High capital costs and O&M requirements.	Not retained because more cost effective options are available.

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Remedial Technology Screening–Groundwater and DNAPL
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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Liquid-phase carbon adsorption	Liquid phase carbon adsorption is a full-scale technology in which ground water is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. When the concentration of contaminants in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed. The two most common reactor configurations for carbon adsorption systems are the fixed bed and the pulsed or moving bed.	Effective for removal of TCE and cis-1,2-DCE. Less effective for VC removal. The technology is well proven, and is frequently part of remedial designs. The bed-life of GAC is usually short-term; however, if concentrations are low enough, the duration may be long-term.	Proven technology. O&M costs may be high depending on system loading and resulting rate of carbon use.	Moderate to high. There are costs to regenerate and replace GAC. Costs are also lower at higher flow rates.	Retained for further evaluation for groundwater.
	Air stripping	Air stripping is a full-scale technology in which volatile organics are partitioned from ground water by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Treatment of air emissions may be necessary.	Removal efficiencies around 99% are typical for towers that have 4.6 to 6 meters (15 to 20 feet) of conventional packing and are removing compounds amenable to stripping. Removal efficiencies can be improved by adding a second air stripper in series with the first, heating the contaminated water, or changing the configuration of packing material. Thermal units for treating air stripper emissions can be used as a source of heat.	Implementable. O&M on the unit due to precipitation on the components. Air strippers are commercially available and widely used.	Moderate to high. Costs increase significantly if air emissions require treatment. At OMC this may be significant because vinyl chloride is not easily removed from air with low cost GAC. A major operating cost of air strippers is the electricity required for the ground water pump, the sump discharge pump, and the air blower. As a general rule, pumps in the 1 to 20-gpm range require from 0.33 to 2 HP; from 20 to 75 gpm power ratings are 1 to 5 HP; and from 100 to 600 gpm, power ratings range from 5 to 30 HP.	Retained for further evaluation for groundwater.
Biological Treatment	Aerobic cometabolic bioremediation	Organics in wastewater oxidized through the use of a mixed culture of organisms in aerobic conditions. Bioreactor combines contaminants, inducers and electron acceptor (oxygen) to enhance aerobic biodegradation. Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade chlorinated VOCs.	Need sufficient organic substrate to sustain organisms.	This is a well developed technology that has been used for many decades in the treatment of municipal and industrial wastewater. However, only in the past decade, studies have been performed to evaluate the effectiveness of bioreactors in treating ground water and leachate from hazardous waste sites. Bioreactor equipment and materials are readily available.	High, requires time to establish biological community, may require addition of substrate if contaminant loading is not sufficient.	Not retained due to more cost effective options available for site contaminants.
	Anaerobic bioremediation	Organics in wastewater oxidized through the use of a mixed culture of organisms in anaerobic conditions. Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Need sufficient organic substrate to sustain organisms. May be effective for CVOCs.	Well-developed technology. Requires sufficient space for large system depending on pumping rate. O&M intensive.	Not cost-competitive with air stripping for the relatively low organic strength water	Not retained due to more cost effective options available for site contaminants.

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Remedial Technology Screening–Groundwater and DNAPL
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Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range	Screening Comment
	Offsite incineration	High temperatures, 870 to 1,200°C (1,400 to 2,200°F), are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Incinerator designs are geared towards different waste streams and different end products, and operating temperatures vary with the different designs. Incineration is different from other thermal technologies in that it oxidizes bulk quantities of waste that may be in liquid and solid phase.	The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99% requirement for hazardous waste and can be operated to meet the 99.9999% requirement for PCBs and dioxins.	Implementable.	Very high.	Retained for further evaluation for disposal of collected DNAPL and DNAPL contaminated soil.
Discharge						
Wastewater discharge	Land application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized.	Poor effectiveness for CVOCs because they are not readily degradable aerobically.	Sufficient space onsite not available and would conflict with future residential land use onsite.	Low to moderate.	Not retained due to lack of effectiveness and land requirements.
	POTW	Aqueous streams are discharged to a POTW for treatment.	VOCs are effectively treated at POTWs to below NPDES discharge requirements.	Implementable provide water meets pretreatment limits.	Low to moderate.	Retained for further evaluation for groundwater.
	Surface water	Discharge of treated groundwater to nearby surface water body.	Effective though discharge to harbor or Lake Michigan may require additional treatment processes to remove inorganics.	Implementable though it requires meeting the substantive requirements of an NPDES permit.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Reinjection	Reinjection of treated groundwater to the aquifer upgradient or side-gradient to the impacted area.	May increase the effectiveness of aquifer restoration due to increased flow rate through aquifer as a result of reinjection.	Implementable. Reinjected water would likely be required to meet drinking water MCL or PRGs.	Low to moderate.	Retained for further evaluation for treated groundwater.
	Evaporation ponds	Surface impounds are used to contain treated or untreated wastewater or groundwater until it evaporates	Ponds would have to be very large to accommodate flow rate and allow time for sufficient volatilization. Air emissions of VOCs would not be controlled.	Not likely to be implementable due to air emissions and large land requirement.	Low to moderate.	Not retained due to air emissions and land requirements.

Note:
Highlighted technologies are screened from further consideration in the assembly of remedial action alternatives.
Effectiveness is the ability to perform as part of an overall alternative that can meet the objective under conditions and limitations that exist onsite
Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the physical, regulatory, technical, and schedule constraints.
Relative cost is for comparative purposes only and it is judged relative to the other processes and technologies that perform similar functions.

In Situ Thermal Desorption. Implementation of in situ thermal desorption involves installation of wells followed by installation of heating elements into each well. Heat is applied to the soil by the heating element in close contact with the soil. This differs from resistance heating as no current is passed through the soil. Thermal conduction of the soil transfers heat away from the heated wells. Heated extraction wells are installed to collect vapors generated by the heating of soils and groundwater. The steam is collected and condensed. The condensation is treated and discharged while VOCs remain in the vapor phase which is treated and released. The cost to implement the in situ thermal desorption process option is moderate to high.

3.6.2 DNAPL Collection

The DNAPL collection response action, if implemented, could potentially use multiple process options. Active extraction could be useful for collecting mobile, easily extractable DNAPL while passive collection or periodic pumping of a collection "sump" could be more effective for residual DNAPL. Treatment and disposal options are likely limited to offsite incineration. The cost of DNAPL collection is low to moderate and is primarily dependent upon the volume of DNAPL recovered and the cost of disposal.

3.6.3 In Situ Soil Mixing

The soil mixing response action, if implemented, would combine a stabilizing amendment such as bentonite clay with a treatment amendment such as ZVI. Soil mixing would utilize large-diameter augers to mix the amendments with the DNAPL and native soils to stabilize the DNAPL while distributing the treatment amendment throughout the mixture. The combination lowers DNAPL mobility while providing treatment of the COCs. The cost of soil mixing is low to moderate and is primarily dependent on the depth to the DNAPL and the size of the DNAPL area.

3.7 Technology and Process Option Screening for Groundwater

Using the same methodology described in the preceding section, Table 3-3 presents the results of a qualitative comparison of technology types and process options available for groundwater remediation. The response actions and associated process options that were retained after screening for remediation of groundwater at the site include the following:

- No further action
- Institutional controls: deed restrictions, permits, and monitoring
- In situ treatment: chemical reduction, electrical resistance heating, thermal desorption, enhanced in situ bioremediation, natural attenuation
- Collection: vertical wells, horizontal wells
- Ex situ treatment: chemical oxidation, carbon adsorption, air stripping
- Discharge: POTW, surface water, reinjection

The rationale for selecting these process options is indicated in Table 3-3. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These technologies include containment, in situ treatment, ex situ groundwater treatment, and groundwater discharge.

3.7.1 Containment

Containment alternatives were considered as part of the evaluation process. Evaluated alternatives include hydraulic gradient control, sheet piling, slurry walls, and permeable reactive barriers. The findings of the RI indicate groundwater contamination from the OMC site is not discharging to Lake Michigan east of the site. In addition, groundwater analytical results indicate groundwater contamination related to the OMC site is not discharging to Waukegan Harbor. The CVOC migration velocities are very slow, and there is substantial natural attenuation occurring. As a result, the most important remedial objectives for groundwater are returning the groundwater to drinking water standards and preventing indoor exposures from volatilization from the plume.

As a result, hydraulic containment or passive reactive barrier technologies with the objective of preventing offsite migration are not currently needed to protect the harbor or lake and do not meet the more important objectives of groundwater restoration to drinking water standards. These technologies were not retained for inclusion in the remedial alternatives.

3.7.2 In Situ Treatment

In situ treatment process options that were evaluated in more detail include the following:

- In situ chemical oxidation
- In situ chemical reduction
- Enhanced reductive dechlorination
- In situ thermal desorption
- Electrical resistance heating

Each process option is presented in greater detail below. Each of these process options have a relatively high cost and would be applied to the more concentrated portions of the plume.

In Situ Chemical Oxidation

This technology involves injection of a strong chemical oxidant (ozone, persulfate, permanganate, or peroxide) into the contaminant plume. The ensuing reaction then oxidizes the organic contaminants it comes into contact with. The oxidation reaction can be highly exothermic with stronger oxidants like peroxide. The vapors and steam generated during the reaction could potentially migrate through underground utilities or piping. These concerns can be addressed by using a slightly weaker oxidant such as permanganate; however, permanganate solution and permanganate solid are a dark purple color. The potential for the oxidant to migrate along utility corridors could result in a discharge of dark purple water to nearby surface water bodies.

The implementation cost of in situ chemical oxidation (ISCO) is considered moderate for source areas. The cost to implement ISCO for the dissolved plume exceeding PRGs is considered high. This is largely the result of the high oxidant demand expected because the aquifer is under strongly reducing conditions with a high organic content of the soil and groundwater. This option was not retained for inclusion in the remedial alternatives due to costs and implementation concerns.

In Situ Chemical Reduction

The in situ chemical reduction (ISCR) process option involves delivering a chemical reducing agent to the subsurface to treat the contaminants. Reducing agents being evaluated include EHC®, Daramend®, and emulsified ZVI. All three reducing agents contain ZVI but vary in the size of the iron particles and the nature of the controlled-release carbon source. The emulsified ZVI is specifically designed to target DNAPL areas. The design of the ISCR amendments is to provide a carbon source to stimulate biological activity while the ZVI provides rapid dechlorination of the CVOCs. The cost of ISCR is estimated at low to moderate and is driven primarily by the longevity of the reducing agents in the subsurface and delivery methods. This option was retained for inclusion in the remedial alternatives.

Enhanced In Situ Bioremediation

Electron donors (hydrogen, lactate, food-grade oils, corn syrup, whey, etc.) are delivered to the subsurface within the target treatment zone to stimulate anaerobic biodegradation of chlorinated solvents by reductive dechlorination. Injection of the substrate would be performed using direct push methods or permanently installed injection wells. The substrate addition would stimulate the native micro-organisms which in turn "consume" the contaminants generating methane/ethane/ethane and other byproducts. Injections would be performed periodically to sustain the biological community. The goal of the enhanced bioremediation alternative would be to reduce contaminant concentrations to levels that can be remediated to PRGs by MNA. The cost of this alternative is considered low to moderate. Enhanced reductive dechlorination was retained for inclusion into remedial alternatives.

In Situ Thermal Desorption

In situ thermal desorption's (ISTD's) primary application uses thermal heating wells, along with heated extraction wells. Heat is applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer are effective near the heating element. As a result, thermal conduction and convection expand into the soil volume. The ISTD process creates a zone of very high temperature (greater than 1,000°F) near the heaters, which can oxidize or pyrolize target constituents. A soil vapor extraction system is used to remove volatilized constituents.

ISTD raises the soil temperature within the treatment volume to the boiling point of water, generating steam in situ. This results in steam distillation of the contaminants. ISTD occurs as vapors are drawn into the hot regions in close proximity to heated extraction wells. The cost of ISTD is high driven primarily by the cost of capital equipment, condensate treatment, and vapor treatment. ISTD was retained for inclusion in the remedial alternatives.

Electrical Resistance Heating

ERH operates under the principal that electrical current passing through a resistive component, such as soil, will generate heat. The amount of current which can be made to flow through a given soil type is a function of the voltage applied and the resistance of the soil. Several factors govern the resistance between adjacent Six-Phase Heating™ (SPH) `electrodes including soil type, moisture content, and the distance between electrodes. Since distance and soil types are fixed components, current flow can be controlled by regulating soil moisture content and the applied voltage.

Electrical current is split into multiple (typically three or six) electrical phases for the electrical resistive heating of soil and groundwater. The electrical current is derived from a centrally located transformer and sent to each of electrodes placed in the subsurface. Soil and groundwater are heated to appropriate temperatures, dependant upon soil type, allowing the volatilization of contaminants. Once soil contaminants are volatilized, they are removed from the subsurface media by a soil vapor extraction system, and treated above ground using conventional methods such as oxidation or adsorption.

By heating subsurface material to the boiling point of water, an in situ source of steam is created which strips contaminants from the soil. The steam serves two purposes. First, its physical action drives contaminants out of portions of the soil that tend to lock in the contaminants via capillary forces. Second, the steam acts as a carrier gas for the contaminants, enabling the contaminants to be swept out of the soil into the vacuum vent by increasing the permeability of the soil.

Thermocouples measure soil temperatures at multiple locations within the treatment area at varying depths. The system requires daily manual adjustments of the electrode voltage and SVE system vacuum. An onsite computer is used to adjust voltages on the transformer to maintain a consistent power input. ERH is a full-scale, batch, in situ technology.

Costs for ERH are moderate to high and are driven primarily by the cost of electricity and the area to be treated. ERH was retained for inclusion in the remedial alternatives.

3.7.3 Ex Situ Treatment

CVOCs are the primary contaminant expected to be present in extracted groundwater that will require treatment to discharge standards prior to reinjection or discharge to surface water. Iron and manganese may also be present in groundwater at elevated concentrations as a result of the reducing conditions in the aquifer. The reducing conditions result in the reduction of iron and manganese naturally present in the aquifer soil to soluble forms. Once these inorganics are no longer under reducing conditions, they would be expected to become oxidized back to their immobile forms. Removal of iron and manganese may be necessary prior to discharge to surface water

The most suitable process options identified for treatment of CVOCs are ultraviolet (UV)/oxidation, carbon adsorption (using granular activated carbon [GAC]) and/or air stripping. The cost for ex situ treatment is moderate to high and is driven primarily by the cost of long-term O&M, utility costs, and capital equipment costs. UV/oxidation was retained primarily because of the presence of relatively high concentrations of vinyl chloride. Vinyl chloride, while easily air stripped, is not easily removed with GAC. If emissions from an air stripper require treatment for vinyl chloride, it may be more cost effective to use UV/oxidation because it destroys the vinyl chloride in the water phase. Each of these technologies was retained and will be evaluated further in the alternative development.

3.7.4 Discharge

Under the discharge response action, the process options of discharge of treated groundwater to the POTW, surface water (North Ditch, South Ditch, Waukegan Harbor) and re-infiltration are retained. Discharge to a surface water such as Lake Michigan or Waukegan Harbor generally has more stringent discharge limits, particularly for inorganics. Each of these discharge options will be evaluated in more detail in the alternative development.

SECTION 4

Alternative Descriptions

4.1 Introduction

The remedial technologies and process options that remain after screening for the building soil and sediment, DNAPL, and groundwater media were assembled into a range of alternatives. The remedial alternatives were developed separately for the building, contaminated soil and sediment, DNAPL, and groundwater to allow a wider range of alternatives and greater flexibility in selecting the recommended alternatives. Soil and sediment media have been combined because the technologies used for each are similar.

The specific details of the remedial components discussed for each alternative are intended to serve as representative examples to allow order-of-magnitude cost estimates. Other viable options within the same remedial technology that achieve the same objectives may be evaluated during remedial design activities for the site. The following sections provide a detailed description of each alternative. Table 4-1 summarizes the developed remedial alternatives.

4.2 Building Materials Alternative Descriptions

Four building material alternatives were developed to address the RAOs for the OMC Plant 2 building. Each of the technologies remaining after screening was incorporated into at least one alternative. For the purposes of this evaluation, building materials are defined as aboveground structures, the concrete slab, and part of the storm sewer system. The concrete footings, tunnel structures, and other underground utilities will be left in place. The portions of the building that are uncontaminated including the New Die Cast Area, Trim Building, and Triax Building and the Corporate Building, and these do not require any remedial action to meet the RAOs (see Figure 2-1). In addition to the building and concrete slab, the unsaturated zone soils adjacent to the building (within 20 feet) are also included to allow the building alternatives to also address soil that will be encountered during demolition.

As previously described in the soil and sediment alternatives, the remediation of unsaturated zone soil below the building slab will be based on COCs, concentrations, and volume that will be determined once the slab is removed. A soil management plan will present the decision framework; for example, soils with PCBs greater than 50 mg/kg will be sent to a TSCA landfill, PCB soil with less than 50 mg/kg will be sent to a Subtitle D landfill or consolidated onsite, and VOC-impacted soil will be treated.

4.2.1 Building Materials Alternative 1—No Further Action

The objective of Building Materials Alternative 1 (B1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of and exposure to contaminants. There would be a risk to trespassers from direct contact with the building materials if the building was not demolished. It is assumed under this alternative that minimal maintenance of the building will continue to be performed by the City of Waukegan and eventually it would deteriorate.

4.2.2 Building Material Alternative 2—Demolition and Offsite Disposal

The objectives of Building Materials Alternative 2 (B2), demolition and offsite disposal, are the prevention of trespasser human exposure to PCBs, through contact, ingestion, or inhalation on building surfaces and surrounding soil and the removal of building materials, concrete slab, and soil within 20 feet of the building in the unsaturated zone, as necessary, to allow site remediation.

The main remedial components of B2 include the following:

- Soil management plan
- Decontamination
- Demolition
- Excavation
- Disposal

A soil management plan would address remediation of the soil and concrete tunnels found underneath the building. The building's concrete footings would remain in-place. Any concrete tunnels uncovered would be sampled after removal of the slab, and disposal options would be evaluated at that time. If they are found to be uncontaminated, they may be filled with uncontaminated concrete rubble.

Prior to decontamination, an asbestos survey and abatement of asbestos containing material would be performed. Following ACM abatement, internal surfaces would be decontaminated, as needed, for cost-effective steel, concrete and equipment reclamation/disposal. Decontamination would be performed by pressure washing or sand blasting in isolated containment zones. Approximately 30 percent of the material is estimated to require sand blasting. Steel with a PCB concentration less than 10 $\mu g/100\ cm^2$ can be recycled as scrap. Approximately 4,000 tons of steel is estimated to be recycled as scrap, as well as significant resale value of the remaining equipment once decontaminated. The final part slated for decontamination would be the storm sewer south of the building where previous soil sampling results have indicated PCB in the catch basins. The length of storm sewer for decontamination is shown on Figure 4-1.

Demolition and recycling of the building structure would be completed next. Construction and demolition debris, cinder block, and storm sewer would be disposed in a Subtitle D landfill. Steel would be sent offsite for scrap. Storm sewer laterals outside the footprint of the building to the south would also be removed up to the lateral. The connection at the lateral would be plugged. Storm sewer would be sent to a Subtitle D landfill. Building material and equipment that could not be decontaminated to below 50 mg/kg would be disposed in a TSCA landfill.

The concrete slab demolition would be the next step. Concrete with PCB greater than 50 mg/kg would be sent to a USEPA-approved TSCA/Subtitle C landfill (estimated 4,750 cubic yards). Concrete with PCB less than 50 mg/kg but greater than 1 mg/kg would be sent offsite to a Subtitle D landfill (estimated 11,173 cubic yards). Concrete with PCB less than 1 mg/kg would be crushed and reused offsite if possible or used to fill the underground tunnels (estimated 1,242 cubic yards).

TABLE 4-1
Remedial Alternative Development
OMC Plant 2 FS

		Building					Soil and Sediment					DNAPL					Groundwater				
General Response Actions	**Remedial Technology/ Process Option**	**B1- No Further Action**	**B2- Demolition and Offsite Disposal**	**B3- Demolition, Offsite Disposal and Onsite Consolidation**	**B4- Demolition, Offsite Disposal and Onsite Consolidation with Harbor Sediments**	**S1- No Further Action**	**S2- Excavation and Offsite Disposal**	**S3- Excavation, Offsite Disposal and Onsite Consolidation**	**S4- Excavation, Offsite Disposal and Onsite Consolidation with Harbor Sediments**	**D1- No Further Action**	**D2- Institutional Controls and Monitoring**	**D3- Extraction, Onsite Collection and Offsite Destruction**	**D4 - In Situ Thermal Treatment**	**D5- In Situ Chemical Reduction Treatment**	**G1- No Further Action**	**G2- Institutional Controls and Monitored Natural Attenuation**	**G3a- Source Zone In Situ Chemical Reduction**	**G3b- Enhanced In Situ Bioremediation**	**G4a- Groundwater Collection and Treatment with Monitored Natural Attenuation**	**G4b- Groundwater Collection and Treatment to MCLs**	**G5- In Situ Thermal Treatment**
No Action	None	X				X				X					X						
Institutional Controls	Deed restrictions			X	X			X	X		X	X	X	X		X	X	X	X		X
	Permits			X	X			X	X		X	X	X	X		X	X	X	X		X
	Monitoring										X	X	X	X		X	X	X	X	X	X
In Situ Treatment	Chemical reduction (ISCR)													X			X				
	Electrical resistance heating (ERH)																				
	In situ thermal desorption (ISTD)												X								X
	Enhanced reductive dechlorination																	X			
	Natural attenuation																X	X	X		X
Collection	Vertical wells											X							X	X	
	Horizontal wells											X							X	X	
Removal	Demolition		X	X	X																
	Excavation						X														
Ex Situ Treatment	High pressure washing, solvent washing, scarifying, wiping		X	X	X																
	Thermal																				
	Chemical oxidation (e.g., UV oxidation)																		X	X	
	Liquid-phase carbon adsorption																		X	X	
	Air stripping																		X	X	
	Offsite incineration											X									
Disposal	Onsite consolidation			X	X			X	X												
	TSCA/ RCRA Subtitle C Landfill		X	X	X		X	X	X												
	Subtitle D Landfill		X				X														
Discharge	POTW																		X	X	
	Surface water																		X	X	
	Reinjection																		X	X	

The last step would be excavation and disposal of the soil exceeding PRGs in the unsaturated zone within 20 feet of the perimeter of the building. This volume is estimated at 11,111 cubic yards. Soil with PCB greater than 50 mg/kg would be sent to a USEPA-approved TSCA/Subtitle C landfill (estimated 10 percent). Soil with PCB less than 50 mg/kg would be sent to a Subtitle D landfill. The excavated area would be backfilled with clean fill material.

4.2.3 Building Material Alternative 3—Demolition, Offsite Disposal, and Onsite Consolidation

Building Material Alternative 3 (B3) is identical to B2 except for the disposal options. In B3, building material and soil with PCBs greater than 50 mg/kg or greater than 100 µg/100 cm^2 would still be disposed in an offsite TSCA/Subtitle C landfill; however, concrete, cinder block, and soil with less than 50 mg/kg of PCBs or less than 100 µg/100 cm^2 would be consolidated onsite in a berm. The cinder block and concrete would be crushed before placing in the berm. Construction and demolition debris would still be sent offsite to the Subtitle D landfill as discussed in Alternative B2.

The berm would be constructed in the area between the existing East and West Containment cells on the northern portion of site. After consolidation of the building material and soils and sediment is completed, the berm would be covered with 12 inches of clean soil and seeded.

4.2.4 Building Material Alternative 4—Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments

Building Material Alternative 4 (B4) is identical to B3 except for the disposal options. In B4, building material and soil with PCBs greater than 50 mg/kg or greater than 100 µg/100 cm^2 would still be disposed in an offsite TSCA/Subtitle C landfill; however, concrete, cinder block, and soil with less than 50 mg/kg of PCBs or less than 100 µg/100 cm^2 would be consolidated onsite in a berm, but the berm would be constructed along the entire length of the northern property boundary to allow future consolidation of Waukegan Harbor sediments.

New containment sidewalls (3 feet tall) would be constructed around the existing East and West Containment cells to allow placement of dewatered sediment and OMC Plant 2 building material, soils, and sediment directly on top. The cells would not be modified, but rather the soil and sediment would be placed directly on top of the existing cells. After construction of the berm is complete, it would be covered with 12 inches of clean soil and seeded.

4.3 Soil and Sediment Alternative Descriptions

Four soil and sediment media alternatives were developed to address a range of remedial actions and include all the remaining technologies into at least one alternative. The soil and sediment alternatives do not include the unsaturated zone soil below the building slab or adjacent to the building (within 20 feet). Soil adjacent to the building is included in building demolition. Soil remediation beneath the building will be based on COCs, concentrations, and volume that will be determined once the slab is removed.

4.3.1 Soil Alternative 1—No Further Action

The objective of Soil Media Alternative 1 (S1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of and exposure to contaminants. There would be a risk from direct contact with the soil if the site was developed in the future for residential use. There would also be ecological risks as described earlier.

4.3.2 Soil Alternative 2—Excavation and Offsite Disposal

The objective of Soil Media Alternative 2 (S2), excavation and offsite disposal, is to prevent residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil and prevention erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk. The volume of soil to be excavated would be based primarily on the presence of PCBs greater than 1 mg/kg. PAHs exceeding PRGs are generally included within this area.

Soils exceeding the PRGs are shown in Figures 2-2 through 2-5 and are separated into surface soil (0 to 2 feet) and unsaturated zone soil (2 to 5 feet). The total estimated volume of PCB- and PAH-contaminated soil exceeding PRGs is approximately 33,000 cubic yards. The total volume of sediment to be excavated is 4,200 cubic yards. The main remedial components of S2 include the following:

- Excavation
- Disposal

Soils exceeding the PRGs would be excavated and segregated by area in separate stockpiles that would be sampled for disposal characteristics. The excavated areas would be backfilled with clean material. The stockpiles would be managed appropriately until approval for disposal was received. Sediment in the drainage ditches would be excavated and dewatered prior to offsite transport. Excavation and dewatering methods would be determined in design. It will be assumed for this FS-level cost estimate that dry excavation techniques would be used.

Excavated soils and sediment would be sent offsite for disposal based on the following criteria:

- PCBs less than 50 mg/kg would be sent to a Subtitle D landfill (estimated 96 percent of total volume)
- PCBs greater than 50 mg/kg would be sent to a USEPA-approved TSCA/Subtitle C landfill (estimated 4 percent of total volume)

4.3.3 Soil Alternative 3—Excavation, Offsite Disposal, and Onsite Consolidation

Soil Media Alternative 3 (S3) is identical to S2 except for the disposal options. In S3, soils with PCBs greater than 50 mg/kg would still be disposed of in an offsite TSCA landfill; however, soils with less than 50 mg/kg of PCBs or soils with PAHs greater than the PRGs would be consolidated onsite in a berm.

The berm would be constructed in the area between the existing East and West Containment cells on the northern portion of site. After consolidation of the soils and sediment is completed, the berm would be covered with 12 inches of clean soil and seeded.

4.3.4 Soil Alternative 4—Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments

Soil Media Alternative 4 (S4) is identical to S3 except for the disposal options. In S4, soils with less than 50 mg/kg of PCBs or soils with PAHs greater than the PRGs would be consolidated onsite in a berm, but the berm would be constructed along the entire length of the northern property boundary to allow future consolidation of Waukegan Harbor sediments.

New containment sidewalls (3 feet tall) would be constructed around the existing East and West Containment cells to allow placement of dewatered sediment and OMC Plant 2 soils directly on top. The cells would not be modified, but rather the soil and sediment would be placed directly on top of the existing cells. After construction of the berm is complete, it would be covered with 12 inches of clean soil and seeded.

4.4 DNAPL Alternative Descriptions

4.4.1 DNAPL Alternative 1—No Further Action

The objective of the DNAPL Media Alternative 1 (D1), the No Further Action Alternative, is to provide a baseline for comparison to other alternatives, as required by the NCP. Alternative D1 does not include any further remedial action for groundwater. It does not include monitoring or institutional controls.

4.4.2 DNAPL Alternative 2—Institutional Controls and Monitoring

The objective of DNAPL Media Alternative 2 (D2) is to rely on institutional controls to prevent exposure of residents or workers to DNAPL COCs and to use monitoring to evaluate whether exposures may be occurring. Institutional controls include well drilling restrictions to prevent exposure to DNAPL. A restrictive covenant would be placed on the OMC property deed that would specify production wells not be installed within the DNAPL area. An institutional control would also be included to require use of subslab vapor control systems for any new structures placed over or in close proximity to the DNAPL area.

4.4.3 DNAPL Alternative 3—Extraction, Onsite Collection, and Offsite Destruction

The objective of DNAPL Media Alternative 3 (D3) removal is to remove free-phase DNAPL to the extent practicable, resulting in a reduction of a secondary source of VOCs to the groundwater. Previous investigations have shown that measurable DNAPL is present just east of the former metal working area. A component of this alternative will be to conduct additional investigations to delineate the areal extent of the DNAPL.

The DNAPL removal system could be implemented as a standalone option or as a component of the groundwater extraction and treatment system. Designated DNAPL recovery systems would be installed in extraction wells where DNAPL has been identified during site investigation activities.

Implementation of the DNAPL recovery system would include installation of a 6-inch-diameter stainless steel well to a depth of 30 feet bgs in the DNAPL area. A DNAPL recovery pump would then be installed at the base of the extraction well. The DNAPL recovery pump would be powered using several solar panels mounted nearby. Solar power is applicable as the DNAPL extraction pump will not operate continuously to allow time for the DNAPL to recover. The DNAPL would be collected in 55-gallon drums stored outside the building on the former gas-cylinder storage platform. The storage area would comply with RCRA secondary containment requirements for hazardous waste. A fence would be constructed to secure the area. It is estimated that 55 gallons of DNAPL will be recovered every 2 months and shipped offsite for disposal as hazardous waste.

4.4.4 DNAPL Alternative 4—In Situ Thermal Treatment

DNAPL Media Alternative 4 (D4) uses in situ thermal treatment to remove DNAPL and reduce CVOC concentrations in the DNAPL area. ISTD could be implemented exclusively for DNAPL treatment or as a component of a larger scale system designed to treat the dissolved phase VOC plume. Thermal treatment would be accomplished using thermal desorption in the DNAPL area presented on Figure 4-2.

ISTD would use thermal wells, along with heated extraction wells. Heat would be applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer would be effective near the heating element. As a result, thermal convection and conduction would occur in the soil volume. The ISTD process would create a zone of very high temperature (greater than 1,000°F) near the heaters, which can oxidize or pyrolize target constituents. ISTD would raise the soil temperature within the treatment volume to the boiling point of water, generating steam in situ. This would result in steam distillation of the contaminants. ISTD would occur as vapors are drawn into the hot regions in close proximity to heated extraction wells. An SVE system would be used to remove volatilized constituents. SVE offgases would be treated in a catalytic oxidizer or similar treatment system.

4.4.5 DNAPL Alternative 5—In Situ Soil Mixing with In Situ Chemical Reduction

The objective of DNAPL Media Alternative 5 (D5) is to incorporate amendments via shallow soil mixing to treat and stabilize DNAPL and increase the surface area of the DNAPL available to micro-organisms for anaerobic biological reductive dechlorination or chemical reduction. The increased surface area also accelerates the dissolution of DNAPL into the groundwater, allowing for more effective treatment by chemical reduction. The amendments would include ZVI and bentonite. The ZVI would corrode in situ releasing hydrogen, which then results in chemical reductive dechlorination of the CVOCs. The bentonite would be added to aid in the soil mixing by reducing the torque needed to rotate the augers. In addition, it would reduce the permeability of the mixed soil so that the mass flux from any untreated residuals is greatly reduced. In situ soil mixing would be used to treat DNAPL areas accessible (that is, outside the building) to the large equipment necessary to implement the alternative. DNAPL areas beneath the building may be addressed using this alternative after demolition of the building.

Prior to implementation of this alternative, the horizontal and vertical extent of the DNAPL area shown on Figure 4-2 would be more precisely delineated. In particular the extent of diffusion of DNAPL into the underlying clay would be evaluated so that the target depth of the soil mixing can be set to include the upper portion of the clay if necessary.

Large-diameter (6 feet or greater) augers would be advanced to the target depth. Upon reaching the target depth, the amendments would be injected through the augers. The augers would be advanced and retracted through the DNAPL interval several times to ensure complete mixing. This process would be repeated until the entire area had been treated.

Quarterly groundwater sampling of eight monitoring wells at four downgradient locations would be performed to monitor if a dissolved phase plume was generated as a result of soil mixing and monitor the changes in the plume, if any, over time. Groundwater samples will be analyzed for VOCs and the following MNA parameters:

- Dissolved oxygen
- Oxidation-reduction potential
- Chloride
- Carbon dioxide
- Manganese
- Total iron, ferrous iron, ferric iron
- Sulfate and sulfide sulfur
- Nitrate and nitrite nitrogen
- Alkalinity
- pH, temperature, specific conductance

4.5 Groundwater Alternative Descriptions

Five groundwater media alternatives were developed to provide a range of remedial actions for groundwater contamination. The remaining technologies were incorporated into at least one alternative.

4.5.1 Groundwater Alternative 1—No Further Action

The objective of the Groundwater Media Alternative 1 (G1), the No Further Action Alternative, is to provide a baseline for comparison to other alternatives, as required by the NCP. Alternative G1 does not include any further remedial action for groundwater. It does not include monitoring or institutional controls.

4.5.2 Groundwater Alternative 2—Institutional Controls and Monitored Natural Attenuation

The objective of Groundwater Media Alternative 2 (G2) is to rely on natural attenuation for remediation of the groundwater plume. Natural attenuation is the process by which contaminant concentrations are reduced by volatilization, dispersion, adsorption, and biodegradation. Based on the site groundwater data, anaerobic conditions are present in the groundwater below the source area and at the plume perimeter. There is evidence of substantial biological degradation of the CVOCs.

The main remedial components of G2 include the following:

- Institutional controls
- MNA

Institutional Controls

Institutional controls include well drilling restrictions to prevent exposure to contaminated groundwater. A restrictive covenant would be placed on the OMC property deed that would specify production wells not be installed within the plume or within areas in proximity to the plume that could affect plume migration. Restrictive covenants may also be necessary for properties south of the site if VOCs remain above the USEPA Region 9 PRGs. An institutional control would also be included to require use of subslab vapor control systems for any new structures placed over or in close proximity to the plume area.

Monitored Natural Attenuation

MNA would be used to assess the degree of natural attenuation and allow estimates of the time necessary to reach PRGs. The lateral extents of groundwater CVOC concentrations exceeding PRGs are shown on Figure 2-7. If monitoring data indicate further spreading of the plume above remedial goals along with a potential for adverse effects on receptors, active restoration with one of the remaining alternatives (G3, G4, or G5) would be implemented.

The objective of the monitoring program would be to collect sufficient information to track the lateral and vertical extent of the VOC contaminant plume, monitor changes in concentrations, and provide additional natural attenuation parameters to evaluate biodegradation of the VOCs. The program would also allow assessment of continued releases from the source area.

The alternative includes development of a spreadsheet-based first-order decay rate natural attenuation model. This model would assist in development of a time estimate to reach PRGs.

The groundwater monitoring network for alternative G2 is assumed to include shallow and deep monitoring wells at 15 locations for a total of 30 monitoring wells. The monitoring wells will be sampled annually and analyzed for VOCs and the following natural attenuation parameters:

- Dissolved oxygen
- Oxidation-reduction potential
- Chloride
- Carbon dioxide
- Manganese
- Total iron, ferrous iron, ferric iron
- Sulfate and sulfide sulfur
- Nitrate and nitrite nitrogen
- Alkalinity
- pH, temperature, specific conductance

4.5.3 Groundwater Alternative G3—Source Zone In Situ Treatment

The objective of Groundwater Media Alternatives 3a and 3b (G3a and G3b) is to treat the VOC source areas and VOC groundwater plume (greater than 1 mg/L VOCs) in situ. In situ alternatives include in situ chemical reduction and in situ bioremediation. Each alternative is presented below.

Groundwater Alternative G3a–In Situ Chemical Reduction

The objective of Groundwater Media Alternative 3a (G3a) is to treat the VOC source areas and the VOC-contaminated groundwater plume (greater than 1 mg/L) by adding amendments to enhance existing anaerobic reducing conditions. The target treatment area is shown on Figure 2-7.

Insoluble chemical amendments (ZVI, carbon sources, or a combination) would be delivered to the aquifer in solid or slurry form. The amendments would create a zone of strongly reducing conditions, accelerating reductive dechlorination of the VOC contaminants. The addition of carbon sources can act as an enhancement to indigenous micro-organisms in the treatment zone, although this alternative is intended to rely primarily on abiotic chemical reduction.

The institutional controls and MNA components for alternative G3a are as described for Alternative G2; however, MNA monitoring for alternative G3a will be performed quarterly for the first 3 years of implementation followed by annual sampling.

The ISCR amendment would be injected into the subsurface as a slurry at a 0.25percent soil-to-mass ratio. This ratio is based on average COC concentrations in areas of the plume exceeding 1 mg/L total CVOCs. The amendment would be delivered to the subsurface using injection by direct push methods. Injection points would be installed in a fence pattern perpendicular to the direction of groundwater flow. Injection points would be placed on 25-foot centers with rows of injection points spaced 100 feet apart. Approximately 139 injection points to a depth of 30 feet bgs are required to treat groundwater in the target treatment zone.

Following emplacement of the ISCR amendment, physical, chemical, and biological processes result in a strongly reducing environment. The emplaced ISCR amendment treats the COCs in groundwater migrating through the amendment barrier and in a zone of strongly reducing conditions extending out from the amendment barrier. As groundwater passes through the series of barriers COCs are degraded or destroyed.

Groundwater Alternative G3b–Enhanced In Situ Bioremediation

The objective of Groundwater Media Alternative 3b (G3b) is to treat the VOC source areas and VOC-contaminated groundwater plume (greater than 1 mg/L VOCs) by adding an organic substrate to stimulate the micro-organisms to metabolize the VOCs. The target treatment area is shown on Figure 2-7.

Enhanced reductive dechlorination is a process in which indigenous or inoculated micro-organisms (for example, fungi, bacteria, and other microbes) degrade (metabolize) the VOCs, converting them to innocuous end products. Soluble nutrients or other amendments may be used to enhance reductive dechlorination and contaminant desorption from subsurface materials.

In the absence of oxygen (anaerobic conditions), the VOCs would be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate would be converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas would ultimately be produced.

The institutional controls and MNA components are as described for Alternative 2; however, MNA monitoring will be performed quarterly for the first 3 years of implementation followed by annual sampling.

EISB implementation will involve the injection of the selected amendment into the shallow and deep intervals of the aquifer. Each material presented would require an aqueous solution be prepared onsite and injected into a series of closely spaced, 2-inch-diameter injection wells. Permanent injection wells, rather than direct push locations, will be installed to allow for future injections. Spacing for the installation of the injection wells is a function of the amendment being added (particle size, viscosity) and achievable injection rate

Permanent injection wells will be installed in a barrier configuration to use natural advective transport as the mechanism to bring dissolved contaminants into contact with the amendments and be reductively dechlorinated. The injection wells will be placed in a line perpendicular to the groundwater flow for the target treatment zone (TTZ). It is expected that only a portion of the contaminant mass will be treated within the injection area and that treatment will continue as the contaminant mass is transported beyond the injection area through the TTZ. The spacing between lines of injection wells was based on an estimated travel time of 2 years for the shallow wells and 3 years for the deep wells. Because of the slower groundwater velocity and higher concentrations of contaminants observed in the deep zone, more injection wells will be installed in the deep zone compared with the shallow zone.

Target enhanced in situ bioremediation (EISB) amendment injection concentrations were developed using site-specific groundwater VOC concentrations along with hydrogeologic data, geochemical data, and subsurface biological data. The target EISB amendment concentrations are designed to achieve and sustain conditions favorable to EISB.

The selected EISB amendment will be combined with water to form a solution that will be injected directly into the injection wells using a pump and manifold system. The solution (or emulsion in the case of EOS) will be pumped into a manifold capable of injecting into as many as eight injection locations simultaneously.

Groundwater samples will be collected using low-flow purge techniques and analyzed for VOCs. In addition to VOCs, the monitoring parameters will be the same as those measured for Alternative G2.

4.5.4 Groundwater Alternative G4—Groundwater Collection and Treatment

The objective of Groundwater Media Alternatives 4a and 4b (G4a and G4b) is to collect and treat the VOC-contaminated groundwater plume ex situ. G4a and G4b are differentiated by the groundwater VOC concentration within the TTZ at which the collection and treatment system would be shut down. G4a would continue extraction and treatment of the contaminated groundwater within the TTZ to a point where further reductions in concentrations have significantly diminished. Further reductions to PRGs would be by MNA. G4b would continue extraction and treatment of the contaminated groundwater plume within the TTZ to VOC concentrations at or below MCLs.

Groundwater Alternative G4a–Groundwater Collection and Treatment with Monitored Natural Attenuation

The main remedial components of G4a include the following:

- Institutional controls
- Groundwater collection and treatment
- MNA

The institutional controls and MNA are as described for G2.

The objective of this component is to treat the VOC-contaminated groundwater plumes exceeding 1 mg/L total VOCs as shown on Figure 2-7. The groundwater extraction treatment system would consist of extraction wells, extraction pumps, connecting piping, controls, treatment train, building, and discharge piping. The goal of groundwater collection and treatment would be to maximize mass removal of VOCs from the groundwater over a reasonable time frame.

Twenty-five 4-inch-diameter steel extraction wells would be installed in the TTZ with 100-foot grid spacing. The extraction wells would be screened from approximately 15 to 30 feet bgs. The selected screened interval will collect water from the shallow (higher permeability) and deep (lower permeability) groundwater zones equally without the need for two extraction wells at each grid node. Groundwater would be extracted at a rate of 2 gallons per minute (gpm) from each extraction well. Groundwater extraction pumps will have adjustable flow rates if monitoring data indicates higher flow rates are necessary. Following groundwater extraction the contaminated groundwater will be piped to the onsite treatment system.

Groundwater treatment would consist of GAC with post-treatment removal of iron. The treated groundwater would be discharged to surface water via a National Pollution Discharge Elimination System (NPDES) permit. Groundwater extraction would be continued until groundwater VOC concentrations reach a point where further reductions in concentrations have significantly diminished. Further reductions to PRGs would be by MNA based on first-order decay modeling. Natural attenuation monitoring would be performed on an annual basis.

Groundwater Alternative G4b–Groundwater Collection and Treatment to MCLs

The main remedial components of G4b include the following:

- Institutional controls
- Groundwater collection and treatment
- MNA

The institutional controls and MNA are as described for G2.

The objective of this component is to treat the VOC-contaminated groundwater plumes exceeding 1 mg/L total VOCs as shown on Figure 2-7. The groundwater extraction treatment system would consist of extraction wells, extraction pumps, connecting piping, controls, treatment train, building, and discharge piping. The goal of groundwater collection and treatment would be to maximize mass removal of VOCs from the groundwater over a reasonable time frame.

Fifty 4-inch-diameter steel extraction wells would be installed in the TTZ with 100-foot grid spacing. The extraction wells would be screened from approximately 15 to 30 feet bgs. The selected screened interval will collect water from the shallow (higher permeability) and deep (lower permeability) groundwater zones equally without the need for two extraction wells at each grid node. Groundwater would be extracted at a rate of 2 gpm from each extraction well. Groundwater extraction pumps will have adjustable flow rates if monitoring data indicates higher flow rates are necessary. Following groundwater extraction the contaminated groundwater will be piped to the onsite treatment system.

Groundwater treatment would consist of GAC with post-treatment removal of iron. The treated groundwater would be discharged to surface water via an NPDES permit. Groundwater extraction would be continued until groundwater VOC concentrations reach MCLs in the TTZ. Performance monitoring would be performed on an annual basis.

4.5.5 Groundwater Alternative G5—In Situ Thermal Treatment

The objective of Groundwater Media Alternative 5 (G5) is to treat the source areas and dissolved VOC plume (concentrations greater than 1 mg/L) as shown on Figure 2-7.

ISTD would use thermal wells, along with heated extraction wells. Heat would be applied to soil from a high-temperature surface in contact with the soil. Thermal radiation and thermal conduction heat transfer would be effective near the heating element. As a result, thermal convection and conduction would occur in the soil volume. The ISTD process would create a zone of very high temperature (exceeding 1,000°F) near the heaters, which can oxidize or pyrolize target constituents. An SVE system would be used to remove volatilized constituents. Treatment of SVE offgas is assumed to be needed to meet air permit limits.

ISTD would raise the soil temperature within the TTZ to the boiling point of water, generating steam in situ. This would result in steam distillation of the contaminants. ISTD would occur as vapors are drawn into the hot regions in close proximity to heated extraction wells.

Four-inch-diameter steel thermal and heated extraction wells would be installed through the building floor and outside the building from top of grade to the base of the aquifer. Heated extraction wells will be ringed with thermal wells to maintain an inward gradient limiting the potential for migration of vapors outside the TTZ. Thermal monitoring points would be installed to measure the distribution of heat in the subsurface. The offgas collected would be piped to an onsite treatment system to remove COCs via thermal oxidation prior to discharge to the atmosphere, if necessary. It is anticipated that 24 months would be required to implement and complete alternative G5.

The goal of ISTD would be treatment of source zones to reduce concentrations of VOCs to levels amenable to MNA within a reasonable time frame. The MNA performance is as described for G2.

SECTION 5

Detailed Analysis of Alternatives

5.1 Introduction

The detailed analysis of alternatives presents the relevant information needed to compare the remedial alternatives for the building materials, soil and sediment, DNAPL, and groundwater media. The detailed analysis of alternatives follows the development of alternatives and precedes the selection of a remedy. The selection of the remedy is conducted following the FS in the USEPA ROD.

Detailed analysis of alternatives consists of the following components:

- A detailed evaluation of each individual alternative against seven NCP evaluation criteria; and
- A comparative evaluation of alternatives to one another with respect to the seven evaluation criteria.

The detailed evaluation is presented in table format. The comparative evaluation is presented in text and highlights the most important factors that distinguish alternatives from each other.

5.2 Evaluation Criteria

In accordance with the NCP, remedial actions must include the following:

- Be protective of human health and the environment
- Attain ARARs or provide grounds for invoking a waiver of ARARs that cannot be achieved
- Be cost effective
- Utilize permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces TMV as a principal element

In addition, the NCP emphasizes long-term effectiveness and related considerations including:

- The long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate
- The short- and long-term potential for adverse health effects from human exposure

- Long-term maintenance costs
- The potential for future remedial action costs if the selected remedial action fails
- The potential threat to human health and the environment associated with excavation, transportation, disposal, or containment

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990 *Federal Register* (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and to select the most appropriate alternative for implementation at the site as a remedial action. The evaluation criteria include the following:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance
- State acceptance

The criteria are divided into three groups: threshold, balancing, and modifying criteria. Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable. The two threshold criteria are overall protection of human health and the environment, and compliance with ARARs. If ARARs cannot be met, a waiver may be obtained in situations where one of the six exceptions listed in the NCP occur (see 40 CFR 300.430 (f)(1)(ii)(C)(1 to 6).

Unlike the threshold criteria, the five balancing criteria weigh the trade-offs between alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria include the following:

- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability
- Cost

The modifying criteria are community and state acceptance. These are evaluated following public comment on the proposed plan and are used to modify the selection of the recommended alternative. The remaining seven evaluation criteria, encompassing both threshold and balancing criteria, are briefly described below.

5.2.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify that a waiver is appropriate.

Overall Protection of Human Health and the Environment

Protectiveness is the primary requirement that remedial actions must meet under CERCLA. A remedy is protective if it adequately eliminates, reduces, or controls current and potential risks posed by the site through each exposure pathway. The assessment with respect to this criterion describes how the alternative achieves and maintains protection of human health and the environment.

Compliance with ARARs

Compliance with ARARs is one of the statutory requirements of remedy selection. ARARs are cleanup standards, standards of control, and other substantive environmental statutes or regulations which are either "applicable" or "relevant and appropriate" to the CERCLA cleanup action (42 United States Code [USC] 9621(d)(2)). Applicable requirements address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site. Relevant and appropriate requirements are those that while not applicable, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to environmental or technical factors at a particular site. The assessment with respect to this criterion describes how the alternative complies with ARARs or presents the rationale for waiving an ARAR. ARARs can be grouped into the following three categories:

- **Chemical-specific:** ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, establish the amount or concentration of a chemical that may remain in or be discharged to the environment.
- **Location-specific:** ARARs restrict the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats.
- **Action-specific:** ARARs include technology- or activity-based requirements that set controls, limits, or restrictions on design performance of remedial actions or management of hazardous constituents.

The identification of ARARs was summarized in Section 2.1 and the analysis of the potential ARARs relative to the remediation of the OMC Plant 2 site are provided in Appendix A.

5.2.2 Balancing Criteria

The five criteria listed below are used to weigh the trade-offs between alternatives.

Long-term Effectiveness and Permanence

This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long term as well as in the short term. The assessment of alternatives with respect to this criterion evaluates the residual risks at a site after completing a remedial action or enacting a no action alternative and includes evaluation of the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The assessment with respect to this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ. The criterion is specific to evaluating only how treatment reduces TMV and does not address containment actions such as capping.

Short-term Effectiveness

This criterion addresses short-term impacts of the alternatives. The assessment with respect to this criterion examines the effectiveness of alternatives in protecting human health and the environment (that is, minimizing any risks associated with an alternative) during the construction and implementation of a remedy until the response objectives have been met.

Implementability

The assessment with respect to this criterion evaluates the technical and administrative feasibility of the alternative and the availability of the goods and services needed to implement it.

Cost

Cost encompasses all engineering, construction, and O&M costs incurred over the life of the project. The assessment with respect to this criterion is based on the estimated present worth of the costs for each alternative. Present worth is a method of evaluating expenditures such as construction and O&M that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. The present worth of a project represents the amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be sufficient to cover all costs associated with the remedial action. As stated in the RI/FS guidance document (USEPA 1988b), these estimated costs are expected to provide an accuracy of plus 50 percent to minus 30 percent. Appendix B provides a breakdown of the cost estimate for each alternative.

The level of detail required to analyze each alternative with respect to the cost criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is conducted in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

The cost estimates presented for each alternative have been developed strictly for comparing the alternatives. The final costs of the project and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, the firm selected for final engineering design, and other variables; therefore, final project costs will vary from the cost estimates. Because of these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

The cost estimates are order-of-magnitude estimates having an intended accuracy range of plus 50 to minus 30 percent. The range applies only to the alternatives as they are described in Section 4 and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial design, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during final design.

5.3 Detailed Analysis of Building Materials Alternatives

The analysis consists of detailed and comparative evaluations of the remedial alternatives.

5.3.1 Detailed Evaluation

The following alternatives were developed and described in Section 4.2 for the building materials:

- Alternative B1 – No Further Action
- Alternative B2 – Demolition and Offsite Disposal
- Alternative B3 – Demolition, Offsite Disposal, and Onsite Consolidation
- Alternative B4 – Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments

These alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.2. The detailed evaluations for these soil media alternatives are presented in Table 5-1.

5.3.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The RAOs for the OMC Plant 2 building materials include the following:

- Prevention of human exposure, through contact, ingestion, or inhalation on building surfaces that present an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Removal of building and concrete slab as necessary to allow site remediation
- Prevention of residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents a hazard index (HI) greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Remediation of contaminated soils below the building slab, as necessary, to prevent leaching of contaminants to groundwater that result in groundwater in excess of the groundwater PRGs

The No Further Action Alternative is not protective because it allows continued contact with the contaminated building materials and does not allow for remediation of the potentially contaminated soil beneath the building that may act as a continuing source of contaminants to groundwater. Also, the building will gradually deteriorate in future years potentially allowing fugitive dust emissions or rainfall into the building with subsequent PCB transport to the soil or surface water.

Alternatives B2 through B4 are considered protective of human health because demolition of the building will essentially eliminate the potential direct contact exposure pathway. In addition, all the disposal options in these alternatives are considered protective of human health and the environment because they all isolate the materials from human contact via soil covers and institutional controls to prevent uncontrolled excavation into the contaminated building materials. A summary of the overall protectiveness of the alternatives is provided in the table below.

Overall Protection of Human Health and the Environment

Does Not Meet Criteria	Meets Criteria
B1	B2, B3, B4

Compliance with ARARs

All alternatives other than Alternative B1 (No Further Action) are expected to comply with ARARs. The most important ARARs to be met relate to TSCA requirements, erosion controls during demolition, and air pollution emission requirements. Specific ARARs are listed in Appendix A. A summary of the compliance with ARARs is provided in the table below.

Compliance with ARARs

Does Not Meet Criteria	Meets Criteria
B1	B2, B3, B4

Long-term Effectiveness and Permanence

The long-term effectiveness and permanence of alternatives is evaluated in terms of the magnitude of residual risk and the adequacy and reliability of controls. The residual risk of Alternative B1 (No Action) would remain at the estimated 2×10^{-5} ELCR for trespasser direct contact. As discussed above though, there are additional risks related to contaminant migration as the building deteriorates over time. The residual risk is identical for Alternatives B2 through B4 because they all will remove the buildings and underlying soil to the same PRG levels. In addition, all use similar treatment methods to reduce PCB concentrations on building materials.

The adequacy and reliability of the disposal methods are considered similar because in each case the building materials and soil with PCBs exceeding 50 mg/kg would be disposed offsite at a RCRA Subtitle C or TSCA landfill. These landfills have multiple liners and cap systems and are tightly controlled. In addition, the contaminants are predominantly the PAHs and PCBs that do not leach readily. The much less contaminated materials disposed onsite under Alternatives B3 and B4 would be covered to prevent direct contact and erosion. These controls are also considered adequate and reliable if the cover is routinely maintained. In comparison, Alternative B2 is considered slightly better than Alternatives B3 and B4 because it does not rely on long-term maintenance of the onsite cover system since all material is disposed offsite.

It will, however, require maintenance of the cover system by the offsite landfill. A summary of the relative ranking of alternatives is provided in the table below.

Long-term Effectiveness and Permanence
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
B1			B3, B4, B2	

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives B2 through B4 all use similar treatment methods to reduce PCB concentrations on building materials and thus maximize recycling and reuse while minimizing concentrations of PCBs in materials for onsite or offsite disposal. High-pressure water washing and sand blasting will be used in each of these alternatives to remove PCBs from surfaces of building materials to below TSCA regulatory levels. Treatment residuals such as wash water and sand blasting grit will be contained and disposed of properly. The NCP preference for treatment would be met by all three of these alternatives. A summary of the relative ranking of alternatives is provided in the table below.

Reduction of Toxicity, Mobility, and Volume through Treatment
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
B1				B2, B3, B4

Short-term Effectiveness

There are no additional risks associated with the actual construction and implementation of Alternative B1 because no remedial action would be taken; however, Alternative B1 has short-term impacts to the community and the environment related to restrictions on possible site use and risk from existing exposure pathways. Alternatives B2, B3, and B4 would have similar impacts with respect to the protection of workers or the environment. In the three alternatives, workers would be exposed to overhead dangers and large equipment during the execution of work. In addition, there is a potential of airborne exposure to asbestos and dust as a result of demolition activities. Stormwater impacts could result from runoff in the area of demolition.

These exposures could be addressed through proper decontamination and abatement prior to demolition and dust suppression and erosion controls during demolition. Assuming adequate monitoring is conducted and proper corrective actions taken, workers and the environment would be protected through air monitoring and stormwater erosion controls.

Alternative B2 provides less protection to the community than the other alternatives because of the short-term impact of the larger number of trucks required to transport the material offsite and through populated areas. Truck traffic would still be significant for Alternatives B3 and B4, but would approximately two-thirds less than for Alternative B2.

Alternative B1 would not meet the RAOs. Alternatives B2, B3, and B4 would achieve RAOs quickly, since they each involve demolition of the building. Alternative B2 would achieve the RAOs most effectively because the material would be removed from the site (approximately 18 months) and disposed of. Alternatives B3 and B4 would require more time because of onsite preparation for consolidation and articulate planning during demolition for placement of materials (approximately 19 months). A summary of the relative ranking of alternatives is provided in the table below.

Short-term Effectiveness
Relative Ranking from Lowest to Highest

Lowest				Highest
0	**1**	**2**	**3**	**4**
B1		B2	B3, B4	

Implementability

The main technical challenge for the Alternatives B3 and B4 is design and preparation of the consolidation area. The onsite containment cells affect the location of consolidation and the structural ability to place materials. Alternatives B3 and B4 would also require institutional controls. All of the alternatives can be implemented with readily available materials and methods.

Cost

An overview of the cost analysis performed for this FS and the detailed breakdowns for each of the alternatives are presented in Appendix B, with the total costs listed in Table 5-1.

The No Further Action Alternative has the least present worth cost, as the only task associated with this alternative is the 5-year review.

The lowest cost alternative, excluding the No Action Alternative, is B3, since this alternative includes the less costly onsite consolidation of material and does not involve additional preparation of the consolidation area for harbor sediments. Alternative B4 would incur the next highest costs due to the capital costs associated with preparing additional surface area for placement of the harbor sediments in the consolidation berm. In Alternative B4, a primary assumption is that the material to be consolidated can be placed on top of the existing containment cells without modification to the cells. A 6-inch-thick compacted soil layer would be placed on top of the cells prior to addition of consolidated material to limit impacts to the existing cells, but no other provisions would be made. Alternative B2 would be the most costly because it involves excavation and offsite disposal of all materials.

5.4 Detailed Analysis of Soil and Sediment Media Alternatives

The analysis of the soil and sediment alternatives consists of detailed and comparative evaluations of the remedial alternatives.

5.4.1 Detailed Evaluation

The following alternatives were developed and described in Section 4.3 for the soil and sediment target areas:

- Alternative S1 – No Further Action
- Alternative S2 – Excavation and Offsite Disposal
- Alternative S3 – Excavation, Offsite Disposal, and Onsite Consolidation
- Alternative S4 – Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments

These alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.2. The detailed evaluations for these soil and sediment media alternatives are presented in Table 5-2.

5.4.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The remedial action objectives pertinent to the soil remediation target areas are as follows:

- Prevention of recreational, residential or construction worker human exposure, through contact, ingestion, or inhalation to contaminated soil that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Prevention of erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk (that is, HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6})

The RAO for the sediment is remediation of sediment in the North and South ditches exceeding a PCB cleanup level of 1 mg/kg.

The No Further Action Alternative is not protective because it allows continued contact with the soil that causes risk estimated to be 4×10^{-4} ELCR and a HI of 4.9. In addition, RAOs for erosion and offsite transport of the soil would not be met because the there would be no measures in place to prevent erosion. Potential risks to ecological receptors may occur if the site is developed in the future and habitat is created in areas with high concentrations of PAHs and PCBs. Also, PCBs may bioaccumulate in fish or erode into Lake Michigan.

Alternatives S2 through S4 are considered protective of human health and the environment because each removes soil and sediment with COCs exceeding the PRGs. The soil and sediment would be disposed in a manner to isolate it from the environment, thus preventing direct contact and erosion. Leaching of PAHs and PCBs to groundwater is not a concern because of limited mobility of these compounds. A summary of the overall protectiveness of the alternatives is provided in the table below.

Overall Protection of Human Health and the Environment

Does Not Meet Criteria	Meets Criteria
S1	S2, S3, S4

Compliance with ARARs

The alternatives other than No Further Action are expected to comply with ARARs. All of the other alternatives include either exposure controls or complete removal. The most important ARARs to be met relate to TSCA requirements, erosion controls during demolition, air pollution emission requirements, and wetland restoration/compensation requirements. Specific ARARs are listed in Appendix A. A summary of the compliance with ARARs is provided in the table below.

Compliance with ARARs

Does Not Meet Criteria	Meets Criteria
S1	S2, S3, S4

Long-term Effectiveness and Permanence

The residual risk of Alternative S1 (No Action) would remain at the estimated 4×10^{-4} ELCR and a HI of 4.9 for exposure to soils. In addition, risks to ecological receptors would remain and risks related to PCB contaminated sediment would remain. The residual risk for Alternatives B2 through B4 is below the NCP risk range and is identical because they all remove the same amount of soil and sediment to the same PRG levels.

The adequacy and reliability of the disposal methods are considered similar because in each case the soil and sediment exceeding 50 mg/kg would be disposed offsite at a RCRA Subtitle C or TSCA landfill. These landfills have multiple liners and cap systems and are tightly controlled. In addition, the contaminants are predominantly the PAHs and PCBs that do not leach readily. The much less contaminated materials disposed onsite under Alternatives S3 and S4 would be covered to prevent direct contact and erosion. These controls are also considered adequate and reliable if the cover is routinely maintained. In comparison, Alternative S2 is considered somewhat better than Alternatives S3 and S4 because it does not rely on long-term maintenance of the onsite cover system since all material is disposed offsite. A summary of the relative ranking of alternatives is provided in the table below.

Long-term Effectiveness and Permanence
Relative Ranking from Lowest to Highest

Lowest				Highest
0	1	2	3	4
S1			S3, S4	S2

Reduction of Toxicity, Mobility, and Volume through Treatment

There are no treatment methods used for Alternatives S1, S2, S3, and S4; therefore, reduction of TMV through treatment is not applicable. Treatment technologies generally were found not to be applicable to the soil and sediment because the COC concentrations are far lower than the levels for which treatment methods were developed. A summary of the relative ranking of alternatives is provided in the table below.

Reduction of Toxicity, Mobility, and Volume through Treatment
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
S1, S2, S3, S4				

Short-term Effectiveness

There are no additional risks associated with the actual construction and implementation of Alternative B1 because no remedial action is taken; however, Alternative B1 would have short-term impacts to the community and the environment related to restrictions on possible site use and risk from existing exposure pathways. Alternatives S2, S3, and S4 have similar impacts with respect to the protection of workers or the environment. In the three alternatives, workers would be exposed to fugitive dust and in situ soil contamination as a result of excavation activities. These exposures could be addressed through proper use of personal protective equipment and dust suppression. Stormwater impacts could result from runoff in the area of excavation and can be controlled through erosion control measures. Ecological damage in the dune area from excavation of PCB contaminated dune sands would require mitigation. Sediment excavation would be performed in the dry if possible to minimize suspension and release of PCB contaminated sediment to Lake Michigan.

Alternative S2 would provide less protection to the community than the other alternatives because of the short-term impact of the larger number of trucks required to transport all of the soil offsite and through population areas. Truck traffic would not be significant for Alternatives S3 and S4.

Alternative S1 will not meet RAOs. Alternatives S2, S3, and S4 achieve RAOs quickly, since they each involve some type of excavation. Alternative S2 achieves RAOs most quickly because the material is removed from the site (approximately 6 months). Alternatives S3 and S4 would require more time because of onsite preparation for consolidation (approximately 7 months). A summary of the relative ranking of alternatives is provided in the table below.

Short-term Effectiveness
Relative Ranking from Lowest to Highest

Lowest 0	1	2	3	Highest 4
S1		S2	S3, S4	

Implementability

The main technical challenge for the Alternatives S3 and S4 is design and preparation of the consolidation area. The onsite containment cells affect the location of consolidation and the structural ability to place materials. Alternatives S3 and S4 would also require institutional controls. All of the alternatives can be implemented with readily available materials and methods.

Cost

An overview of the cost analysis performed for this FS and the detailed breakdowns for each of the alternatives are presented in Appendix B, with the costs listed in Table 5-2.

The No Further Action Alternative has the least present worth cost, as the only task associated with this alternative is the 5-year review.

The lowest cost alternative, excluding the No Action Alternative, is S3, since this alternative includes the less costly onsite consolidation of soil and sediment and does not involve additional preparation of the consolidation area for harbor sediments. Alternative S4 would incur the next highest costs due to the capital costs associated with preparing additional surface area for placement of the harbor sediments in the consolidation berm. In Alternative S4, a primary assumption is that the soil and sediment to be consolidated can be placed on top of the existing containment cells without modification to the cells. A 6-inch-thick, compacted soil layer would be placed on top of the cells prior to addition of consolidated material to limit impacts to the existing cells, but no other provisions would be made. Alternative S2 would be the most costly because it involves excavation and offsite disposal of all soil and sediment.

5.5 Detailed Analysis of DNAPL Alternatives

5.5.1 Detailed Evaluation

The following alternatives for DNAPL were developed and described in Section 4.4:

- Alternative D1—No Further Action
- Alternative D2—Institutional Controls and Monitoring
- Alternative D3—Extraction, Onsite Collection, and Offsite Destruction
- Alternative D4—In Situ Thermal Treatment
- Alternative D5—In Situ Chemical Reduction Treatment

These five alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.2. The detailed evaluations for these DNAPL media alternatives are presented in Table 5-3.

5.5.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The RAOs for remediation of DNAPL at the OMC Plant 2 site include the following:

- Prevention of residential indoor inhalation of VOCs that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Prevention of construction worker exposure to groundwater, through contact, ingestion, or inhalation that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Remediate contamination in groundwater to concentrations below an HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6}within a reasonable time frame

- Remediate DNAPL and groundwater within the DNAPL area to the extent practicable and minimize further migration of contaminants in groundwater

The No Further Action Alternative is not considered protective because it does not include groundwater monitoring or institutional controls to prevent access to DNAPL. Future exposure to groundwater contaminated from TCE dissolving from the DNAPL would result in risks of 2×10^{-2} ELCR and a HI of 325. Also, future risks from vapor intrusion from groundwater into homes would be unabated at a risk of 6×10^{-4} ELCR and HI of 3.

The remaining alternatives are considered protective because they all include, at a minimum, restrictive covenants on the property deeds to prevent groundwater use, groundwater monitoring to verify natural attenuation is occurring, and requirements for vapor control systems for buildings built over or near the DNAPL. Alternative D2 reduces the potential human exposure and slowly returns groundwater to PRGs, however, it is less protective since the migration and dissolution of DNAPL in groundwater could still occur.

Alternative D3 involves removal of the mobile DNAPL pool. It contributes to achieving the first three RAOs by slightly reducing a continuing source of VOCs to the groundwater; however, only the mobile DNAPL can be removed. Residual (non-pumpable) DNAPL will remain and continue to act as a source of VOCs to the groundwater. The great majority of the estimated 90,000 pounds of TCE in the DNAPL area would remain under this alternative.

Alternatives D4 and D5 are the most protective of human health and the environment as both mobile and residual DNAPL are addressed. In Alternative D4, DNAPL and groundwater in the DNAPL treatment zone are rapidly heated to the boiling point generating steam which in turn boils and strips the DNAPL from the subsurface. The offgas produced is then extracted using SVE and, if necessary, the condensate and vapor phase are treated above ground prior to discharge. Treatment can be completed approximately 1 year after system operation begins. In situ thermal desorption has achieved variable results at other sites, but typically 75 percent or more of the DNAPL mass can be removed with in situ thermal desorption.

In situ chemical reduction, Alternative D5, also aggressively addresses mobile and residual DNAPL resulting in protection of human health and the environment. Mobile and residual DNAPL in the treatment zone are stabilized in a clay matrix combined with ZVI. The ZVI provides accelerated reductive dechlorination of the TCE DNAPL while the clay limits dissolution or migration of untreated DNAPL into the groundwater. The advantage of Alternative D4 over alternative D5 is the shorter treatment time required for treatment of DNAPL by Alternative D4. Also, the soil mixing component allows homogenation of the soil, including the upper clay, to enable good contact between the ZVI reducing agent and the contaminated soil. A summary of the overall protectiveness of the alternatives is provided in the table below.

Overall Protection of Human Health and the Environment

Does Not Meet Criteria	Meets Criteria
D1	D2, D3, D4, D5

Compliance with ARARs

Appendix A presents a compilation of all the state and federal chemical-specific, location-specific, and action-specific ARARs considered for the OMC Plant 2 site. With the exception of Alternative D1, the DNAPL remedial alternatives meet ARARs. DNAPL treatment Alternatives D4 and D5 would meet ARARs in less time than Alternatives D2 and D3.

A waste handling plan would be developed under Alternative D3 to meet RCRA- and IEPA-specific hazardous waste treatment, storage, and disposal ARARs. Air and condensate treatment for the emissions under Alternative D4 would be implemented to meet Clean Air Act and applicable IEPA-specific ARARs. The substantive requirements for obtaining an injection permit would be met for Alternative D4. A summary of the compliance with ARARs is provided in the table below.

Compliance with ARARs

Does Not Meet Criteria	Meets Criteria
D1	D2, D3, D4, D5

Long-term Effectiveness and Permanence

The long-term effectiveness and permanence of the In Situ Thermal Treatment Alternative (D4) and the In Situ Chemical Reduction Alternative (D5) exceed the effectiveness and permanence of Alternative D3 because mobile and residual DNAPL are addressed. Alternative D3 removes minimal DNAPL, so the long-term risks are largely unchanged with this alternative.

Alternative D4 ranks similar to D5 in long-term effectiveness and permanence. Alternative D4 removes DNAPL from the majority of the subsurface Alternative D5 has the advantage of homogenizing the soil and the upper portion of the clay to achieve good contact of ZVI with the contaminated soil while also adding clay to reduce the mass flux of any remaining untreated TCE by several orders of magnitude. The remaining alternatives, No Further Action (D1) and MNA (D2), are similar in their long-term effectiveness and permanence, which is significantly less than Alternatives D4 and D5 since natural processes are the only technology relied on to reduce DNAPL mass. A summary of the relative ranking of alternatives is provided in the table below.

Long-term Effectiveness and Permanence
Relative Ranking from Lowest to Highest

Lowest				Highest
0	1	2	3	4
D1	D2	D3		D4, D5

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives D4 and D5 provide the greatest reduction of DNAPL volume and mobility and indirectly reducing the toxicity. Alternative D5 immediately reduces the mobility, while the heat generated by Alternative D4 may result in short-term increases in the mobility of the DNAPL. Alternative D4 reduces the volume of DNAPL by extraction of the vapor phase, while the ISCR component of Alternative D5 requires a longer period time to reduce the volume of DNAPL by degradation. Alternatives D4 and D5 are estimated to remove more than 70,000 pounds of the estimated 90,000 pounds of TCE in the DNAPL.

Alternative D3 follows D4 and D5 in the reduction of mobility and volume of DNAPL. The extraction of the mobile DNAPL provides a rapid decrease in volume; however, a majority of the mass of residual DNAPL will remain in the subsurface where the toxicity is not reduced. Alternatives D1 and D2 do not reduce the toxicity, mobility, or volume of DNAPL due to the lack of active treatment and do not meet the statutory preference for treatment. A summary of the relative ranking of alternatives is provided in the table below.

Reduction of Toxicity, Mobility, and Volume through Treatment
Relative Ranking from Lowest to Highest

Lowest				Highest
0	**1**	**2**	**3**	**4**
D1, D2	D3			D4, D5

Short-term Effectiveness

There are no additional risks associated with the actual construction and implementation of the No Further Action Alternative (D1) and the MNA Alternative (D2) because no remedial construction is undertaken. These alternatives (D1 and D2), however, have short-term impacts to the community and the environment related to restrictions on possible site use and risk from existing exposure pathways. Alternatives D3, D4, and D5 have minimal to moderate impacts with respect to the protection of workers during remedial construction, protection of the community during remedial action, and environmental impacts of remedial action.

Alternative D3 has a relatively small potential to impact workers, the community, and the environment during installation of the extraction and collection system and during handling of the collected DNAPL during transportation for disposal. The potential for contact with the DNAPL is highest during installation of the extraction well, during handling of the DNAPL for disposal, and potentially during transportation of the DNAPL to the disposal facility. Some emissions of vapors during extraction well installation are unavoidable, though risks to public health would be minimized through the use of proper personal protective equipment, emission control measures, and air monitoring. Alternative D4, In Situ Thermal Treatment, has a much greater potential impact on workers because it has much more infrastructure and processes that will handle high concentration CVOCs and DNAPL. Alternative D5 has the greatest potential for risks to workers because the soil mixing of ZVI produces hydrogen gas that must be monitored to avoid explosive conditions. Alternative D5 must also include good erosion controls to minimize environmental impacts as a result of the soil mixing.

The short-term effectiveness with respect to the time until the RAOs are achieved is shortest for the In Situ Thermal Treatment Alternative (D4) and In Situ Soil Mixing Alternative (D5) because these alternatives actively reduce the mass of DNAPL. For Alternative D4, it is anticipated that removal of the DNAPL mass in the treatment zone could be accomplished in approximately 2 years after system startup. Alternative D5 will immediately stabilize the

DNAPL mass and require approximately 2 years to achieve substantial treatment of the TCE DNAPL mass.

Alternatives D1, D2, and D3 will likely require more than 50 years to meet the RAOs for DNAPL, with Alternative D3 requiring slightly less time because the mobile DNAPL will have been extracted. A summary of the relative ranking of alternatives is provided in the table below.

Short-term Effectiveness
Relative Ranking from Lowest to Highest

Lowest				Highest
0	1	2	3	4
D1, D2	D5	D4	D3	

Implementability

All alternatives can be implemented at the site, and no technical or administrative implementability problems are expected; however, it has been assumed that the building will remain in place for Alternative D4 as a location to place the offgas treatment system. For Alternative D5, the stabilized area should remain undisturbed until sampling results indicate the DNAPL has been fully degraded.

Cost

A summary of the estimated costs for each of the groundwater media alternatives is presented on Table 5-3 and in more detail in Appendix B. The table breaks down the estimated capital, O&M, and present net worth cost.

The No Further Action Alternative has the least present worth cost, as the only task associated with this alternative is the 5-year review (assumed for 50 years).

The highest present worth cost would result from Alternative D4 at $6.55 million. The treatment requires extensive capital equipment and labor for construction. The next highest cost would be incurred from Alternative D3, at $978,000 to implement, followed by Alternative D5 at $749,000. Alternative D2 has the lowest cost ($690,000) of the alternatives, with the exception of the No Further Action Alternative (D1).

5.6 Detailed Analysis of Groundwater Alternatives

5.6.1 Detailed Evaluation

The following alternatives for groundwater were developed and described in Section 4:

- Alternative G1—No Further Action
- Alternative G2—Institutional Controls and Monitored Natural Attenuation
- Alternative G3a—In Situ Chemical Reduction
- Alternative G3b—Enhanced In Situ Bioremediation

- Alternative G4a – Groundwater Collection and Treatment with Monitored Natural Attenuation
- Alternative G4b – Groundwater Collection and Treatment to MCLs
- Alternative G5 – In Situ Thermal Treatment

These seven alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.2. The detailed evaluations for these groundwater media alternatives are presented in Table 5-4.

5.6.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The RAOs for remediation of groundwater at the OMC Plant 2 site include the following:

- Prevention of residential indoor inhalation of VOCs that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Prevention of construction worker exposure to groundwater, through contact, ingestion, or inhalation that presents an HI greater than 1 or an ELCR greater than 1×10^{-4} to 1×10^{-6}
- Remediate contamination in groundwater to concentrations below an HI greater than 1 or ELCR greater than 1×10^{-4} to 1×10^{-6}within a reasonable time frame
- Remediate DNAPL and groundwater within the DNAPL area to the extent practicable and minimize further migration of contaminants in groundwater

The No Further Action Alternative is not considered protective because it does not include groundwater monitoring or institutional controls to prevent access to contaminated groundwater. Future exposure to groundwater would result in risks of 2×10^{-2} ELCR and an HI of 325. Also, future risks from vapor intrusion from groundwater into homes would be unabated at a risk of 6×10^{-4} ELCR and HI of 3.

The remaining alternatives are considered protective. Alternative G2, MNA with Institutional Controls, is considered protective because it includes restrictive covenants on the property deeds to prevent groundwater use and it includes groundwater monitoring to verify natural attenuation. Alternative G2 eliminates human contact and slowly returns groundwater to MCLs; however, it is less protective because the migration of CVOCs could still occur in the groundwater. Also, the volatilization of VOCs to indoor air would be controlled only through institutional controls that require vapor control systems.

Alternative G3a involves construction of multiple treatment zones comprised of a chemical reducing agent in a configuration perpendicular to groundwater flow. As groundwater flows through the treatment zone, the natural reductive dechlorination process is chemically accelerated. Alternative G3 achieves the first three RAOs over several years as the pore volume of contaminated groundwater pass through the treatment zones. The removal of the contaminant sources (contaminated soil and/or DNAPL) eliminates the influx of additional contaminated groundwater.

Alternative G3b achieves the first three RAOs over several years by injection of biological amendments resulting in enhancement of the native biomass present in the aquifer. The enhanced biomass accelerates the natural reductive dechlorination process. Similar to Alternative G3a, biological amendments are injected into the groundwater; however, the biological amendment is soluble and can be transported by the advection of the groundwater enhancing the biomass as it travels rather than being stationary and requiring the groundwater to pass through a barrier as in Alternative G3b. As a result, Alternative G3b is considered more protective than Alternative G3a.

Alternatives G4a and G4b both address the first three RAOs by extracting contaminated groundwater and treating it using an onsite treatment system. Alternative G4b includes a larger network of extraction wells to remediate groundwater to MCLs, while alternative G4a is intended to treat only the more contaminated groundwater (greater than 1 mg/L CVOCs) to levels amenable to MNA. Alternative G4b will achieve the RAOs in a shorter period of time than Alternative G4a. Alternatives G4a and G4b are considered somewhat less protective than G3a and G3b because they rely only on aquifer flushing to reduce concentrations whereas in situ treatment treats both the dissolved and adsorbed phases of contamination. Relatively small hotspots of DNAPL or very high dissolved phase CVOCs are more likely to be successfully treated under Alternatives G3a and G3b than with aquifer flushing of Alternatives G4a and G4b.

Alternative G5 addresses all four RAOs by rapidly heating groundwater to the boiling point generating steam which in turn strips CVOCs from the subsurface. The steam offgas produced is then extracted using SVE and, if necessary, the condensate and vapor phase are treated above ground prior to discharge. Thermal treatment would remediate areas of highest CVOC concentrations and DNAPL to concentrations amenable to further reduction by MNA. A summary of the overall protectiveness of the alternatives is provided in the table below.

Overall Protection of Human Health and the Environment

Does Not Meet Criteria	Meets Criteria
G1	G2, G4a, G4b, G3a, G3b, G5

Compliance with ARARs

Appendix A presents a compilation of all the state and federal chemical-specific, location-specific, and action-specific ARARs considered for the OMC Plant 2 site. With the exception of the No Further Action Alternative, all remedial alternatives would meet ARARs. None of the alternatives are expected to reach the PRGs during the active phase of the treatment process because of the difficulty in removing adsorbed phase CVOCs to concentrations below 1 µg/L. As a result, all rely on MNA to eventually reach the PRGs. The In Situ Treatment Alternatives (G3 and G5) are expected to reduce the mass of CVOCs in the aquifer much more rapidly than natural attenuation of Alternative G2 or aquifer flushing of Alternative G4.

Air treatment for the emissions under the In Situ Thermal Treatment Alternative (G5) would be implemented if required to meet Clean Air Act and applicable IEPA-specific ARARs. The substantive requirements for obtaining injection or surface water discharge permits would be met for each alternative. A summary of the compliance with ARARs is provided in the table below.

Compliance with ARARs

Does Not Meet Criteria	Meets Criteria
G1	G2, G3a, G3b, G4a, G4b, G5

Long-term Effectiveness and Performance

The long-term effectiveness and permanence of the In Situ Thermal Treatment Alternative (G5) and the Enhanced In Situ Bioremediation Alternative (G3b) are the best of all alternatives because they include active treatment of TCE, cis-1,2-DCE and vinyl chloride in groundwater and are able to directly treat DNAPL. Alternative G5 in particular ranks high because the residual heat from thermal treatment after the system is turned off and stimulates biological treatment of any residual contamination. In addition, the effectiveness of Alternative G5 is less influenced by the presence of low-permeability zones.

The In Situ Chemical Reduction Alternative (G3a) is the next best alternative relative to long-term effectiveness and permanence. It has the ability to treat dissolved and adsorbed phases and high concentration areas but is limited by the lessened transport of the reducing agent to all downgradient areas. The efficiency of the Groundwater Extraction Alternatives (G4a and G4b) are directly influenced by the permeability of the aquifer and the presence of small DNAPL or high concentration areas. Pump and treat alternatives typically reach an asymptotic concentration far above PRGs as a result of dissolution from adsorbed contamination or slow diffusion out of lower permeability areas.

The remaining alternatives, No Further Action (G1) and MNA with Institutional Controls (G2), are similar in their long-term effectiveness and permanence, which is less than Alternatives G3a, G3b, G4a, G4b, and G5, since natural processes are the only technology relied on to reduce the concentrations of CVOCs. A summary of the relative ranking of alternatives is provided in the table below.

Long-term Effectiveness and Performance
Relative Ranking from Lowest to Highest

Lowest				Highest
0	**1**	**2**	**3**	**4**
G1	G2, G4a	G4b, G3a	G3b	G5

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative G5 is the best alternative for reduction of TMV as it removes and destroys the largest mass of TCE, cis-1,2-DCE, and vinyl chloride including DNAPL. It would remove most of the estimated 5,300 pounds in the remedial target area. Alternative G5 also is anticipated to require the least amount of time to achieve a measurable reduction in TMV.

The In Situ Treatment Alternatives (G3a and G3b) are also expected to remove a large majority of the estimated 5,300 pounds in the remedial target area. As discussed earlier, Alternative G3b is considered more effective than G3a. The Groundwater Extraction

Alternative G4b targets the plume exceeding MCLs, an area estimated to have 5,500 pounds of CVOCs. Alternative G4a targets the plume exceeding 1 mg/L CVOCs, or an estimated 5,300 pounds. As discussed earlier, however, a substantial amount of the CVOC mass may not be readily removable with pump and treat. Both alternatives remove the contaminants from the subsurface for treatment at an onsite treatment system prior to discharge. Alternatives G1 and G2 do not reduce the TMV of contaminants due to the lack of active treatment and do not meet the statutory preference for treatment. A summary of the relative ranking of alternatives is provided in the table below.

Reduction of Toxicity, Mobility, and Volume through Treatment
Relative Ranking from Lowest to Highest

Lowest				**Highest**
0	**1**	**2**	**3**	**4**
G1, G2	G4a	G4b	G3a, G3b	G5

Short-term Effectiveness

There are no additional risks associated with the actual construction and implementation of the No Further Action Alternative (G1) and the MNA with Institutional Controls Alternative (G2) because no remedial construction is undertaken. These alternatives (G1 and G2), however, have short-term impacts to the community and the environment related to restrictions on possible site use and risk from existing exposure pathways. Alternative G3a has potential risks to workers related to the generation of hydrogen gas as the injected ZVI corrodes. Monitoring for explosive conditions and precautions when working around wells in the injection area will be needed to minimize risks to workers. The amounts of hydrogen potentially generated, however, are relatively small and threats to those outside the immediate area of the injection are expected to be minimal.

Alternative G3b has minimal impacts with respect to the protection of workers during remedial construction. Alternatives G3a and G3b have minimal impacts with respect to the protection of the community during remedial action. Injections of ZVI and substrate into the aquifer both result in reducing conditions that may mobilize iron and manganese. Although the discharge and subsequent precipitation of iron and manganese are not expected to adversely impact aquatic life in the harbor, the migration of these compounds will need to be closely monitored. Alternatives G4a and G4b have standard safety issues for workers due to the substantial construction required for installation of subsurface piping, installation and connection of electrical equipment, and construction of the onsite treatment system. These are mitigated through adherence to good work practices and a focus on worker safety.

The In Situ Thermal Alternative (G5) also has standard safety issues for workers due to the extensive electrical installations, piping installations, and construction of the air and condensate treatment systems.

The short-term effectiveness with respect to the time until the RAOs are achieved is shortest for the In Situ Thermal Treatment Alternative (G5). The In Situ Chemical Reduction Alternative (G3a) and Enhanced In Situ Bioremediation Alternative (G3b) will require less time than the Pump and Treat Alternatives (G4a and G4b) because they more effectively treat areas of concentrated contamination

The No Further Action Alternative (G1) and MNA with Institutional Controls Alternative (G2) are expected to require more than 50 years to achieve the PRGs for groundwater. A summary of the relative ranking of alternatives is provided in the table below.

Short-term Effectiveness
Relative Ranking from Lowest to Highest

Lowest				**Highest**
0	**1**	**2**	**3**	**4**
G1,G2	G3a	G3b	G5	G4a, G4b

Implementability

All alternatives can be implemented at the site, and no technical or administrative implementability problems are expected for any of the alternatives. However, it has been assumed that the building will remain in place during implementation of all alternatives.

Cost

A summary of the estimated costs for each of the groundwater media alternatives is presented on Table 5-3 and in more detail in Appendix B. The table breaks down the estimated capital, O&M, and present net worth cost.

The No Further Action Alternative has the least present worth cost, as the only task associated with this alternative is the 5-year review (assumed for 50 years).

The highest present worth cost would result from Alternative G5 at $33.3 million. The treatment requires extensive capital equipment, labor, and operations. The second highest present worth cost would result from implementation of Alternative G4b at $11.0 million. The treatment requires extensive capital equipment with annual O&M costs of $509,000. The next highest cost would be incurred from Alternative G3a at $10.6 million to implement followed by Alternative G3b at $8.6 million, and Alternative G4a at $7.8 million. Alternative G2 has the lowest cost ($2.9 million) of the alternatives with the exception of No Further Action Alternative (G1).

TABLE 5-1
Detailed Evaluation of Building Materials Remedial Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative B1—No Further Action	Alternative B2—Demolition and Offsite Disposal	Alternative B3—Demolition, Offsite Disposal, and Onsite Consolidation	Alternative B4— Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
1. Overall protection of human health and the environment.	• Direct contact with building materials could cause risks of 2 x 10^{-5} ELCR. • RAOs for groundwater would not be met because contaminated soil under the slab would not be remediated, thus potentially serving as a continuing source to groundwater. • Gradual uncontrolled deterioration of the building may result in fugitive dust and asbestos emissions and potentially PCBs from water leaking through roofing.	• Building materials and soil will be removed from the site which will eliminate onsite risk due to human contact exposure pathway. • Though unlikely, human contact exposure could occur during the transportation to the offsite disposal facility.	• Building materials and soil presenting the greatest risk will be removed from the site. • Consolidation, soil covering and institutional controls will prevent direct contact risks and migration via erosion.	• Building materials and soil presenting the greatest risk will be removed from the site. • Consolidation, soil covering and institutional controls will prevent direct contact risks and migration via erosion.
2. Compliance with ARARs[a]	• Monitoring of soil is not conducted so remedial time frame would remain unknown.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of building materials and soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste disposal regulations.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of building materials and soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste regulations.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of building materials and soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste regulations.
3. Long-term effectiveness and permanence				
(a) Magnitude of residual risks	• Risk would remain constant over several decades as building materials and soil containing PCBs and PAHs naturally attenuate very slowly to concentrations less than PRGs.	• No residual risk from building materials. • Soil left in place after excavation would be below PRGs. Residual risk is less than the USEPA risk range.	• Soil left in place after excavation would be below PRGs. Residual risk is less than USEPA risk range. • Exposure to contaminants in building materials and soil in consolidated area would be prevented through placement of a cover and ICs.	• Soil left in place after excavation would be below PRGs. Residual risk is less than USEPA risk range. • Exposure to contaminants in building materials and soil in consolidated area would be prevented through placement of a cover and ICs.
(b) Adequacy and reliability of controls	• Not applicable.	• Offsite disposal is adequate and reliable in preventing direct contact with building materials and soil with concentrations exceeding PRGs.	• Offsite disposal is adequate and reliable in preventing direct contact with building materials and soil with concentrations exceeding TSCA. • Consolidation and institutional controls are adequate and reliable in preventing direct contact with other building materials and soils but will require maintenance.	• Offsite disposal is adequate and reliable in preventing direct contact with building materials and soil with concentrations exceeding TSCA. • Consolidation and institutional controls are adequate and reliable in preventing direct contact with other building materials and soils but will require maintenance.
4. Reduction of toxicity, mobility, or volume through treatment				
(a) Treatment process used	• Not applicable.	• High pressure water washing and sand blasting of building materials to remove PCBs to allow recycle/reuse or disposal as a solid waste • Soil below building may require treatment to meet LDRS prior to disposal offsite in a landfill.	• High pressure water washing and sand blasting of building materials to remove PCBs to allow recycle/reuse or disposal as a solid waste • Soil below building may require treatment to meet LDRS prior to disposal offsite in a landfill.	• High pressure water washing and sand blasting of building materials to remove PCBs to allow recycle/reuse or disposal as a solid waste • Soil below building may require treatment to meet LDRS prior to disposal offsite in a landfill.
(b) Degree and quantity of TMV reduction	• Not applicable.	• Washing and sand blasting are effective technologies in reducing PCBs to below regulatory levels on nearly all building materials other than impregnated concrete.	• Washing and sand blasting are effective technologies in reducing PCBs to below regulatory levels on nearly all building materials other than impregnated concrete.	• Washing and sand blasting are effective technologies in reducing PCBs to below regulatory levels on nearly all building materials other than impregnated concrete.
(c) Irreversibility of TMV reduction	• Not applicable.	• Irreversible.	• Irreversible.	• Irreversible.
(d) Type and quantity of treatment residuals	• None, because no treatment included.	• Treatment residuals are contaminated water and sand blast grit. Amounts are not quantifiable at this time but may be substantial..	• Treatment residuals are contaminated water and sand blast grit. Amounts are not quantifiable at this time but may be substantial..	• Treatment residuals are contaminated water and sand blast grit. Amounts are not quantifiable at this time but may be substantial..
(e) Statutory preference for treatment as a principal element	• Preference not met for building materials or soil because no treatment included.	• Preference met for building materials and possibly for soil because treatment is included.	• Preference met for building materials and possibly for soil because treatment is included.	• Preference met for building materials and possibly for soil because treatment is included.

TABLE 5-1
Detailed Evaluation of Building Materials Remedial Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative B1—No Further Action	Alternative B2—Demolition and Offsite Disposal	Alternative B3—Demolition, Offsite Disposal, and Onsite Consolidation	Alternative B4— Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
5. Short-term effectiveness				
(a) Protection of workers during remedial action	• No remedial construction, so no risks to workers.	• Building demolition could result in potential exposure of workers by overhead dangers and large equipment. • Building demolition could result in potential exposure of workers via inhalation (PCBs in concrete paint, asbestos, lead). • Excavation of soil could result in potential exposure of workers via inhalation. • Proper health and safety procedures such as air monitoring, abatement, demolition procedures, and use of Level C respirator protection would be included in the Health and Safety Plan for construction.	• Building demolition could result in potential exposure of workers by overhead dangers and large equipment. • Building demolition could result in potential exposure of workers via inhalation (PCBs in concrete and paint, asbestos, lead). • Excavation of soil could result in potential exposure of workers via inhalation. • Proper health and safety procedures such as air monitoring, abatement, demolition procedures, and use of Level C respirator protection would be included in the Health and Safety Plan for construction.	• Building demolition could result in potential exposure of workers by overhead dangers and large equipment. • Building demolition could result in potential exposure of workers via inhalation (PCBs in concrete and paint, asbestos, lead). • Excavation of soil could result in potential exposure of workers via inhalation. • Proper health and safety procedures such as air monitoring, abatement, demolition procedures, and use of Level C respirator protection would be included in the Health and Safety Plan for construction.
(b) Protection of community during remedial action	• No remedial construction, so no short-term risks to community.	• There are short-term risks to community due to the truck traffic associated with offsite disposal of building materials and soil An estimated 60 trucks/day for over 15 days results in a total of 926 truckloads transported offsite. • Dust emissions are expected during demolition and excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community.	• There are short-term risks to community due to the truck traffic associated with offsite disposal of building materials and soil. An estimated 37 trucks/day for 1 day results in a total of 37 truckloads transported offsite. • Dust emissions are expected during demolition and excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community.	• There are short-term risks to community due to the truck traffic associated with offsite disposal of building materials and soil. An estimated 37 trucks/day for 1 day results in a total of 37 truckloads transported offsite. • Dust emissions are expected during demolition and excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community.
(c) Environmental impacts of remedial action	• No remedial construction, so no environmental impacts from remedial action.	• Storm water re-routing would be required during and after demolition and excavation. • Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants, containments, and implementation of an erosion control plan.	• Storm water re-routing would be required during and after demolition and excavation. • Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants, containments, and implementation of an erosion control plan.	• Storm water re-routing would be required during and after demolition and excavation. • Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants, containments, and implementation of an erosion control plan.
(d) Time until RAOs are achieved	• The RAOs to prevent trespasser, residential, and construction worker human exposure would not be met. • The RAO to remove the building and concrete slab would not be met.	• The building demolition activities would immediately eliminate building materials above PRGs. The time for demolition and offsite disposal is about 16 months. • The excavation activities would immediately eliminate soil concentrations above PRGs. The total time for excavation, disposal, and backfill to meet RAOs is about 2 months.	• The building demolition activities would immediately eliminate building materials above PRGs. The time for demolition, offsite disposal and onsite consolidation is about 17 months. • The RAOs would be met following excavation, backfill, and consolidation. Estimated to require about 2 months.	• The building demolition activities would immediately eliminate building materials above PRGs. The time for demolition, offsite disposal and onsite consolidation is about 17 months. • The RAOs would be met following excavation, backfill and consolidation. Estimated to require about 2 months.
6. Implementability				
(a) Technical feasibility	• No impediments.	• No impediments.	• The main technical challenge is consolidating materials with the onsite containment cells.	• The main technical challenge is consolidating materials with the onsite containment cells.
(b) Administrative feasibility	• No impediments.	• No impediments.	• Requires institutional controls.	• Requires institutional controls.
(c) Availability of services and materials	• None needed.	• Services and materials are available. Prices of salvaged steel are fluctuating significantly and may result in building demolition costs different than those currently estimated.	• Services and materials are available. Prices of salvaged steel are fluctuating significantly and may result in building demolition costs different than those currently estimated.	• Services and materials are available. Prices of salvaged steel are fluctuating significantly and may result in building demolition costs different than those currently estimated..
7. Total Cost				
Direct Capital Cost	• $0	• $13,770,000	• $12,800,000	• $13,250,000
Annual O&M Cost	• $0	• $0	• $9,200	• $10,500
Total Present Worth Cost	• $0	• $13,770,000	• $13,040,000	• $13,520,000

TABLE 5-2
Detailed Evaluation of Soil and Sediment Remedial Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Excavation and Offsite Disposal	Alternative S3—Excavation, Offsite Disposal, and Onsite Consolidation	Alternative S4— Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
1. Overall protection of human health and the environment.	• Direct contact with soils could cause risks of 4 x 10^4, exceeding the 10^{-4} to 10^{-6} ELCR range and a HI = 4.9, exceeding the target HI of 1. • Potential risks to ecological receptors may occur if the site is developed in the future and habitat is created in areas with high concentrations of PAHs and PCBs, • PCBs in sediment may bioaccumulate in fish and erode to Lake Michigan • Erosion of soils exceeding direct contact PRGs will continue.	• Soils exceeding PRGs will be removed from the site which will eliminate onsite risk due to human contact exposure pathway and offsite transport via erosion. • Risks to ecological receptors eliminated through removal of soil with elevated PAHs and PCBs. • Removal of PCB-contaminated sediment prevents bioaccumulation and erosion to Lake Michigan. • Though unlikely, human contact exposure could occur during the transportation to the offsite disposal facility.	• Soil presenting the greatest risk will be removed from the site. • Consolidation, covering with clean soil and institutional controls will prevent direct contact risks and erosion of contaminated soils exceeding PRGs. • Risks to ecological receptors eliminated through removal of soil with elevated PAHs and PCBs. • Removal of PCB-contaminated sediment prevents bioaccumulation and erosion to Lake Michigan.	• Soil presenting the greatest risk will be removed from the site. • Consolidation, covering with clean soil and institutional controls will prevent direct contact risks and erosion of contaminated soils exceeding PRGs. • Risks to ecological receptors eliminated through removal of soil with elevated PAHs and PCBs. • Removal of PCB-contaminated sediment prevents bioaccumulation and erosion to Lake Michigan.
2. Compliance with ARARs[a]	• Monitoring of soil is not conducted so remedial time frame would remain unknown.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste disposal regulations. • Excavation of sediments may affect wetlands. If so wetlands ARARs such as Executive Order 11990-Protection of Wetlands will be met.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste disposal regulations. • Excavation of sediments may affect wetlands. If so wetlands ARARs such as Executive Order 11990-Protection of Wetlands will be met.	• Must meet substantive requirements for air pollution control using dust suppression. • Requires proper protection of streams, wetlands, and other bodies during construction. • Final disposition of soils will be managed according to the requirements of TSCA and Illinois solid and hazardous waste disposal regulations. • Excavation of sediments may affect wetlands. If so wetlands ARARs such as Executive Order 11990-Protection of Wetlands will be met.
3. Long-term effectiveness and permanence				
(a) Magnitude of residual risks	• Risk would remain constant over several decades as soil contaminants naturally attenuate only very slowly to concentrations less than PRGs.	• Soil left in place after excavation would be below PRGs. Residual risk is less than USEPA risk range. • Sediment with PCBs < 1 mg/kg would remain.	• Soil left in place after excavation would be below PRGs. Residual risk is less than USEPA risk range. • Exposure to contaminants in soil in consolidated area would be prevented through placement of a cover and ICs. • Sediment with PCBs < 1 mg/kg would remain.	• Soil left in place after excavation would be below PRGs. Residual risk is less than USEPA risk range. • Exposure to contaminants in soil in consolidated area would be prevented through placement of a cover and ICs. • Sediment with PCBs < 1 mg/kg would remain.
(b) Adequacy and reliability of controls	• Not applicable.	• Offsite disposal is adequate and reliable in preventing direct contact and erosion of soil with concentrations exceeding PRGs.	• Offsite disposal is adequate and reliable in preventing direct contact and erosion of soil with concentrations exceeding TSCA. • Consolidation and institutional controls are adequate and reliable in preventing direct contact with impacted soils but will require maintenance.	• Offsite disposal is adequate and reliable in preventing direct contact and erosion of soil with concentrations exceeding TSCA. • Consolidation and institutional controls are adequate and reliable in preventing direct contact with impacted soils but will require maintenance.
4. Reduction of toxicity, mobility, or volume through treatment				
(a) Treatment process used	• Not applicable.	• No treatment processes used.	• No treatment processes used.	• No treatment processes used.
(b) Degree and quantity of TMV reduction	• Not applicable	• No treatment processes used.	• No treatment processes used.	• No treatment processes used.
(c) Irreversibility of TMV reduction	• Not applicable	• Not applicable since no TMV reduction seen.	• Not applicable since no TMV reduction seen.	• Not applicable since no TMV reduction seen.
(d) Type and quantity of treatment residuals	• None, because no treatment included.	• Not applicable.	• Not applicable.	• Not applicable.
(e) Statutory preference for treatment as a principal element	• Preference not met for soil and sediment because no treatment included.	• Preference not met for soil and sediment because no treatment included.	• Preference not met for soil and sediment because no treatment included.	• Preference not met for soil and sediment because no treatment included.
5. Short-term effectiveness				
(a) Protection of workers during remedial action	• No remedial construction, so no risks to workers.	• Excavation soil could result in potential exposure of workers via inhalation. Proper health and safety procedures such as air monitoring and use of Level C respirator protection would be included in the Health and Safety Plan for construction.	• Excavation soil could result in potential exposure of workers via inhalation. Proper health and safety procedures such as air monitoring and use of Level C respirator protection would be included in the Health and Safety Plan for construction.	• Excavation soil could result in potential exposure of workers via inhalation. Proper health and safety procedures such as air monitoring and use of Level C respirator protection would be included in the Health and Safety Plan for construction.

TABLE 5-2
Detailed Evaluation of Soil and Sediment Remedial Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Excavation and Offsite Disposal	Alternative S3—Excavation, Offsite Disposal, and Onsite Consolidation	Alternative S4— Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ There are limited risks to the community during excavation, due to limited traffic access for trucks hauling impacted soils. Dust emissions are expected during excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the number of trucks used to transport excavated soils. An estimated 60 trucks/day for slightly less than 51 days results in a total of 3,052 truckloads of soil and sediment transported offsite.	▪ There are limited risks to the community during excavation, due to limited traffic access for trucks hauling impacted soils. Dust emissions are expected during excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the truck traffic associated with offsite disposal of TSCA soil and sediment. An estimated 60 trucks/day for over 2 days results in a total of 122 truckloads of TSCA soil and sediment transported offsite.	▪ There are limited risks to the community during excavation, due to limited traffic access for trucks hauling impacted soils. Dust emissions are expected during excavation of impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the truck traffic associated with offsite disposal of TSCA soil and sediment. An estimated 60 trucks/day for over 2days results in a total of 122 truckloads of TSCA soil and sediment transported offsite.
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts from remedial action.	▪ Storm water re-routing would be required during and after excavation. ▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Ecological damage to the dune area from excavation of PCB-contaminated dune sands will be mitigated by planting to reestablish the native flora. ▪ Sediment excavation in the dry will be preferred to minimize suspension and release of PCB-contaminated sediment to Lake Michigan.	▪ Storm water re-routing would be required during and after excavation. ▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Ecological damage to the dune area from excavation of PCB-contaminated dune sands will be mitigated by planting to reestablish the native flora. ▪ Sediment excavation in the dry will be preferred to minimize suspension and release of PCB-contaminated sediment to Lake Michigan.	▪ Storm water re-routing would be required during and after excavation. ▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan. ▪ Ecological damage to the dune area from excavation of PCB-contaminated dune sands will be mitigated by planting to reestablish the native flora. ▪ Sediment excavation in the dry will be preferred to minimize suspension and release of PCB-contaminated sediment to Lake Michigan.
(d) Time until RAOs are achieved	▪ The RAOs to prevent residential and construction worker human exposure and erosion and transport offsite would not be met.	▪ The excavation activities would immediately eliminate soil concentrations above PRGs. The total time for excavation, disposal, and backfill to meet RAOs is about 6 months.	▪ The RAOs would be met following excavation, backfill, and consolidation. Estimated to require about 7 months.	▪ The RAOs would be met following excavation, backfill and consolidation. Estimated to require about 7 months.
6.Implementability				
(a) Technical feasibility	▪ No impediments.	▪ No impediments.	▪ The main technical challenge is consolidating materials with the onsite containment cells.	▪ The main technical challenge is consolidating materials with the onsite containment cells.
(b) Administrative feasibility	▪ No impediments.	▪ No impediments.	▪ Requires institutional controls.	▪ Requires institutional controls.
(c) Availability of services and materials	▪ None needed.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.
7. Total Cost				
Direct Capital Cost	▪ $0	▪ $7,580,000	▪ $5,490,000	▪ $5,940,000
Annual O&M Cost	▪ $0	▪ $0	▪ $9,300	▪ $9,300
Total Periodic Cost	▪ $0	▪ $0	▪ $170,000	▪ $170,000
Total Present Worth Cost	▪ $0	▪ $7,580,000	▪ $5,800,000	▪ $6,250,000

TABLE 5-3
Detailed Evaluation of DNAPL Media Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative D1 No Further Action	Alternative D2 Institutional Controls and Monitoring	Alternative D3 Extraction, Onsite Collection, and Offsite Destruction	Alternative D4 In-Situ Thermal Treatment	Alternative D5 In-Situ Chemical Reduction Treatment
1. Overall Protection of Human Health and the Environment.	• The DNAPL will continue to contribute to groundwater resulting in TCE, cis-1,2-DCE, vinyl chloride and arsenic continuing to persist in groundwater at concentrations exceeding the PRGs. If groundwater were used for drinking, risks would be 2 x 10^{-2} ELCR and a HI = 325, both well higher than the NCP risk range. Also future risks from vapor intrusion from groundwater into homes would be unabated at 6 x 10^{-4} ELCR and HI = 3, also higher than the risk range. • There is a potential for human exposure to DNAPL since no institutional controls are part of this alternative even though groundwater is not used for potable purposes in the area.	• The DNAPL will continue to contribute to groundwater resulting in TCE, cis-1,2-DCE, vinyl chloride and arsenic continuing to persist in groundwater at concentrations exceeding the PRGs. • The potential for human exposure to DNAPL will be minimized through institutional controls that require vapor control systems below buildings and that do not allow use of onsite groundwater. Under this alternative, the institutional controls will be required to be in effect indefinitely. • Future use of the groundwater supply will be limited due to the institutional controls.	• This alternative removes free-phase DNAPL to reduce the mass of DNAPL contributing to the dissolved phase groundwater plume. The proportion though of the estimated 90,000 lbs of TCE DNAPL mass removed by this alternative however is small and as a result it will have minimal effect on overall protection of human health and the environment. • The potential for human exposure to residual DNAPL in the subsurface will also be minimized through institutional controls that require vapor control systems below buildings and that do not allow use of onsite groundwater. Under this alternative, the institutional controls will be required to be in effect for decades.	• This alternative is expected to reduce the mass of DNAPL by 75 percent or more, thus greatly reducing continued dissolution of TCE to groundwater and reducing the potential for risks from vapor intrusion into buildings. • The potential for human exposure to DNAPL will be minimized through institutional controls. Under this alternative the institutional controls will be required to be in effect for years, though less time than alternatives D1, D2 or D3.	• This alternative is expected to reduce the mass of DNAPL 75% or more and reduce the permeability of the DNAPL area, thus greatly diminishing TCE mass flux to the groundwater and vapor emissions to overlying buildings. • The potential for human exposure to DNAPL will be minimized through institutional controls and the reduction in mobility/mass of DNAPL. Under this alternative the institutional controls will be required to be in effect for years, though less time than alternatives D1, D2, or D3.
2. Compliance with ARARs[a]	• Would meet ARARs when DNAPL contamination does not generate groundwater concentrations of TCE, cis-1,2-DCE, and vinyl chloride that exceed groundwater PRGs. Under this alternative, exceedances may persist indefinitely.	• Would meet ARARs when DNAPL contamination does not generate groundwater concentrations of TCE, cis-1,2-DCE, and vinyl chloride that exceed groundwater PRGs. Under this alternative, exceedances may persist indefinitely.	• Would meet ARARs when DNAPL contamination does not result in concentrations of TCE, cis-1,2-DCE, and vinyl chloride that exceed groundwater PRGs. Under this alternative, exceedances may persist indefinitely.	• Would meet ARARs when TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater does not result in concentrations that exceed PRGs.	• Would meet ARARs when DNAPL contamination does not result in concentrations of TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater that exceed PRGs.
3. Long-Term Effectiveness and Permanence					
(a) Magnitude of residual risks	• No significant change in risk because no action taken. Risk relating to dissolution of DNAPL into TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater exceeding groundwater PRGs would persist indefinitely.	• No significant change in risk because no action taken. Risk relating to dissolution of DNAPL into TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater exceeding groundwater PRGs would persist indefinitely.	• Since this option is applicable only for active collection and treatment of mobile DNAPL, long-term risks related to residual (non-pumpable) DNAPL will remain indefinitely.	• Thermal treatment will treat the mobile and residual DNAPL mass reducing risks associated with the DNAPL. Residual risks associated with impacted groundwater will be addressed by the selected groundwater alternative.	• Insitu chemical reduction via soil mixing will treat the mobile and residual DNAPL mass reducing risks associated with the DNAPL. Residual risks associated with impacted groundwater will be addressed by the selected groundwater alternative.
(b) Adequacy and reliability of controls	• Not applicable.	• Requires reliance on institutional controls for DNAPL area and groundwater. These controls may be necessary indefinitely under this alternative.	• Requires reliance on institutional controls for DNAPL area and groundwater. These controls may be necessary indefinitely under this alternative.	• Does not rely on controls specifically related to the DNAPL area.	• Does not rely on controls specifically related to the DNAPL area.
4. Reduction of Toxicity, Mobility, or Volume through Treatment					
(a) Treatment process used	• Not applicable.	• Natural attenuation only.	• Mobile DNAPL mass is reduced by extraction and disposal. Offsite disposal via incineration is the mot likely treatment process.	• Mobile and residual DNAPL are treated by heating the subsurface, generating steam to volatilize the CVOCs. Offgas is extracted using SVE and, if necessary, treated prior to discharge.	• Mobile and residual DNAPL is mixed with a bentonite clay combined with ZVI. The mixing ensures complete contact between the ZVI and DNAPL allowing degradation by ISCR. The clay reduces the permeability of the treated area so that the mass flux from any residual untreated TCE is reduced significantly.
(b) Degree and quantity of TMV reduction through Treatment	• Not applicable.	• Natural attenuation of DNAPL would take multiple decades.	• Mobile DNAPL would be targeted for extraction, residual (non-pumpable) DNAPL would remain in the treatment area. The total mass of TCE DNAPL removed is expected to be a small percent of the existing mass (i.e., less than 10 percent).	• Would remove an estimated 70,000 lbs or more of the 90,000 lbs of TCE estimated to be present in the DNAPL area.	• Would remove an estimated 70,000 lbs or more of the 90,000 lbs of TCE estimated to be present in the DNAPL area. Would reduce the mass flux of any remaining TCE by several orders-of-magnitude.
(c) Irreversibility of TMV reduction	• Not applicable.	• Natural degradation of VOCs is irreversible.	• Extraction and destruction of the DNAPL is irreversible.	• Volatilization of the VOCs is irreversible.	• Chemical reduction of the DNAPL is irreversible. • The clay mixture must remain hydrated to stabilize the DNAPL.

TABLE 5-3
Detailed Evaluation of DNAPL Media Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative D1 No Further Action	Alternative D2 Institutional Controls and Monitoring	Alternative D3 Extraction, Onsite Collection, and Offsite Destruction	Alternative D4 In-Situ Thermal Treatment	Alternative D5 In-Situ Chemical Reduction Treatment
(d) Type and quantity of treatment residuals	• None, no treatment included.	• None.	• Residual DNAPL would remain in the subsurface acting as a source of groundwater contamination.	• Residual groundwater contamination will be addressed by the selected groundwater alternative.	• The structural properties of the soil can be impacted. This can be addressed by the addition of cement in the mixture near the ground surface. • DNAPL stabilized in the mixture is rapidly degraded leaving no residuals • Residual groundwater contamination will be addressed by the selected groundwater alternative.
(e) Statutory preference for treatment as a principal element	• Preference not met for groundwater because no treatment included.	• Preference not met for DNAPL or groundwater because no treatment beyond natural attenuation included.	• Preference not met for all the DNAPL area because a portion of the DNAPL remains in-situ.	• Preference met because DNAPL is treated.	• Preference met because DNAPL is treated.
5. Short-Term Effectiveness					
(a) Protection of workers during remedial action	• No remedial construction, so no risks to workers.	• No remedial construction, so no risks to workers.	• Moderate risks to workers during construction or operation of the extraction system due to potential contact with DNAPL. Appropriate health and safety procedures must be followed.	• Moderate risks to workers during construction or operation of the thermal treatment system due to electrical hookups at each well. Proper health and safety procedures must be followed during construction and operation. Building security would be a priority to prevent tampering.	• Moderate risks to workers during construction or operation of the mixing system due to the large equipment. Proper health and safety procedures must be followed during construction and operation. • Risks to workers during soil mixing are present as a result of the potential generation and accumulation of hydrogen gas. Accumulation of hydrogen will be monitored to prevent explosive conditions and the health and safety plan would also specify additional measures. • Monitoring would be necessary to determine if any DNAPL vapors are emitted.
(b) Protection of community during remedial action	• No remedial construction, so no short-term risks to community.	• No remedial construction, so no short-term risks to community.	• Minimal risks to the community during construction and extraction. Operation and maintenance activities consist of periodic transport of the DNAPL offsite. DNAPL containment area outside the building will be secured.	• Minimal risks to the community during construction and operation. Offgas treatment will be provided as necessary to meet the air permit discharge limits and protect the community from air emissions. The system will be installed primarily inside the building and produces little to no noise.	• Minimal risks to the community during construction and operation. DNAPL areas are not located near neighboring properties. Implementation of this alternative can be completed in several weeks.
(c) Environmental impacts of remedial action	• No remedial construction, so no environmental impacts.	• No remedial construction, so no environmental impacts.	• No environmental impacts during construction or operation of the system.	• No environmental impacts during construction or operation of the system.	• Minimal areas of the ground surface will be disturbed. Areas are currently paved and the facility is not operating.
(d) Time until RAOs are achieved	• Long-term attainment of groundwater RAOs will take decades to meet under this alternative. • Other remaining RAOs are not met.	• Long-term attainment of groundwater RAOs will take decades to meet under this alternative. • Other remaining RAOs are not met.	• Long-term attainment of groundwater RAOs will require decades to meet under this alternative.	• The RAO for DNAPL can be met in several years.	• The RAO for DNAPL can be met in several years.
6. Implementability					
(a) Technical feasibility	• No impediments.	• No impediments	• No impediments.	• Technically feasible though effectiveness may be limited for DNAPL that has diffused into the underlying clay.	• Areas must be accessible to crane mounted equipment with no substantial overhead or underground obstructions. Effectiveness is accentuated by the soil mixing that allows homogenizing of soil to increase contact of ZVI and TCE and allows treatment of upper clay.
(b) Administrative feasibility	• No impediments.	• No impediments.	• No impediments are expected.	• The building must remain in place to house the treatment system, minimize infiltration of stormwater, and assist with SVE of offgas.	• Treatment area should remain undisturbed until ISCR treatment of DNAPL is completed.

TABLE 5-3
Detailed Evaluation of DNAPL Media Alternatives
OMC Plant 2 FS

Alternative Description: Criterion	Alternative D1 No Further Action	Alternative D2 Institutional Controls and Monitoring	Alternative D3 Extraction, Onsite Collection, and Offsite Destruction	Alternative D4 In-Situ Thermal Treatment	Alternative D5 In-Situ Chemical Reduction Treatment
(c) Availability of services and materials	▪ None needed.	▪ None needed.	▪ Necessary engineering services and materials readily available for installation and operation of extraction system.	▪ Necessary engineering services and materials are readily available for installation and operation of system.	▪ Necessary engineering services and materials are readily available for installation and operation of system.
7. Total Cost	Total Capital Cost $0	Total Capital Cost $15,000	Total Capital Cost $154,240	Total Capital Cost $4,500,000	Total Capital Cost $561,400
	Annual O&M Cost $0	Annual O&M Cost $19,000	Annual O&M Cost $19,094	Annual O&M Cost $995,000	Annual O&M Cost $19,200
	Total Periodic Cost $150,000	Total Periodic Cost $150,000	Total Periodic Cost $150,000	Total Periodic Cost $30,000	Total Periodic Cost $30,000
	Total Present Worth Cost $73,000	Total Present Worth Cost $690,000	Total Present Worth Cost $977,600	Total Present Worth Cost $6,554,000	Total Present Worth Cost $749,000

TABLE 5-4
Detailed Evaluation of Groundwater Media Alternatives
OMC Plant 2 Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1 No Further Action	Alternative G2 MNA and Institutional Controls	Alternative G3a In-Situ Chemical Reduction (ISCR)	Alternative G3b Enhanced In Situ Bioremediation (EISB)	Alternative G4a Groundwater Collection and Treatment with MNA	Alternative G4b Groundwater Collection and Treatment to MCLs	Alternative G5 In-Situ Thermal Treatment
1. Overall Protection of Human Health and the Environment.	▪ TCE, cis-1,2-DCE, and vinyl chloride will continue to persist in groundwater at concentrations exceeding the PRGs. If groundwater were used for drinking, risks would be 2 x 10^{-2} ELCR and a HI = 325, both higher than the NCP risk range. Also future risks from vapor intrusion from groundwater into homes would be unabated at 6 x 10^{-4} ELCR and HI = 3, also higher than the risk range. ▪ Although groundwater is not currently used as a drinking water source, there is a potential for future human exposure to contaminated groundwater since no institutional controls are part of this alternative.	▪ TCE, cis-1,2-DCE, and vinyl chloride will continue to persist in groundwater at concentrations exceeding the PRGs. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls that require vapor control systems below buildings and that do not allow use of onsite groundwater. Under this alternative, the institutional controls will be required to be in effect for decades. ▪ Future use of the groundwater supply will be limited due to the institutional controls.	▪ This alternative reduces the groundwater concentrations of TCE, cis-1,2-DCE, and vinyl chloride in groundwater in suspected source areas and areas with the highest concentrations (>1 mg/L), thus reducing the timeframe to meet the PRGs. The total CVOC mass targeted for treatment is 96 percent of the total mass present in groundwater. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hotspots of DNAPL or very high dissolved phase CVOCs can be successfully treated ▪ MNA will be utilized for the remainder of the VOC plume which will take decades to achieve PRGs. ▪ The potential for human exposure to contaminated groundwater will also be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades, though much less time than Alternatives G1 and G2.	▪ This alternative reduces the groundwater concentrations of TCE, cis-1,2-DCE, and VC in groundwater in suspected source areas and areas with the highest concentrations (>1 mg/L), thus reducing the timeframe to meet the PRGs. The total CVOC mass targeted for treatment is 96% of the total mass present in groundwater. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hotspots of DNAPL or very high dissolved phase CVOCs can be successfully treated ▪ MNA will be utilized for the remainder of the VOC plume which will take decades to achieve PRGs. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades, though less time than Alternatives G1 and G2.	▪ This alternative reduces the groundwater concentrations of TCE, cis-1,2-DCE, and vinyl chloride in suspected source areas and areas with the highest concentrations (>1 mg/L), thus reducing the timeframe to meet the PRGs. The total CVOC mass targeted for treatment is 96 percent of the total mass present in groundwater. ▪ Aquifer flushing has poor effectiveness for treating small areas of DNAPL or areas of very high dissolved phase CVOCs. These areas are likely present but cannot be readily delineated. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for years to decades, though less time than Alternatives G1 and G2.	▪ This alternative actively reduces the concentrations of TCE, cis-1,2-DCE, and vinyl chloride in groundwater over the entire plume, thus reducing the timeframe to meet the PRGs. The total CVOC mass targeted for treatment is more than 99 percent of the total mass present in groundwater. ▪ Aquifer flushing has poor effectiveness for treating small areas of DNAPL or areas of very high dissolved phase CVOCs. These areas are likely present but cannot be readily delineated. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for years though less time than the other alternatives.	▪ This alternative actively reduces the concentrations of TCE, cis-1,2-DCE, and vinyl chloride in groundwater in areas of the plume where total CVOC concentrations exceed 1 mg/L. The total CVOC mass targeted for treatment is 96 percent of the total mass present in groundwater. ▪ Treats both dissolved and adsorbed phases of contamination. Relatively small hotspots of DNAPL or very high dissolved phase CVOCs can be successfully treated. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative the institutional controls will be required to be in effect for years, though less time than alternatives G1 or G2.
2. Compliance with ARARs	▪ Would meet ARARs when TCE, cis-1,2-DCE, vinyl chloride and arsenic contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would take decades and may persist indefinitely if DNAPL is not treated.	▪ Would meet ARARs when TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would take decades and may persist indefinitely if DNAPL is not treated.	▪ Would meet ARARs when TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater do not result in concentrations that exceed groundwater PRGs. ▪ The substantive requirements for an injection permit would be met prior to implementation of this alternative.	▪ Would meet ARARs when TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater do not result in concentrations that exceed groundwater PRGs. VOCs would remain above PRGs for decades. ▪ The substantive requirements for an injection permit would be met prior to implementation of this alternative.	▪ Would meet ARARs when TCE, cis-1,2-DCE , and vinyl chloride contamination in groundwater does not result in concentrations that exceed groundwater PRGs. Pumping is expected to continue for 10 years under this alternative followed by MNA for much longer. ▪ The substantive requirements for an NPDES permit for discharge of treated groundwater would be met prior to implementation of this alternative.	▪ Would meet ARARs when TCE, cis-1,2-DCE , and vinyl chloride contamination in groundwater does not result in concentrations that exceed groundwater PRGs. Pumping is expected to continue for 20years under this alternative. ▪ The substantive requirements for an NPDES permit for discharge of treated groundwater would be met prior to implementation of this alternative.	▪ Would meet ARARs when TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater does not result in concentrations than exceed PRGs. Thermal treatment is expected to continue for approximately 1 year followed by years of MNA.

TABLE 5-4
Detailed Evaluation of Groundwater Media Alternatives
OMC Plant 2 Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1 No Further Action	Alternative G2 MNA and Institutional Controls	Alternative G3a In-Situ Chemical Reduction (ISCR)	Alternative G3b Enhanced In Situ Bioremediation (EISB)	Alternative G4a Groundwater Collection and Treatment with MNA	Alternative G4b Groundwater Collection and Treatment to MCLs	Alternative G5 In-Situ Thermal Treatment
3. Long-Term Effectiveness and Permanence							
(a) Magnitude of residual risks	• No significant change in risk because no action taken. Reduction in risk relating to TCE, cis-1,2- DCE, and vinyl chloride contamination in groundwater exceeding groundwater PRGs would occur slowly over decades.	• No significant change in risk because no action taken. Reduction in risk relating to TCE, cis-1,2-DCE, and vinyl chloride contamination in groundwater exceeding groundwater PRGs would occur slowly over decades.	• Risks related to ingestion of groundwater will remain for decades following in situ treatment. Risks related to volatilization of VOCs to indoor air are less likely to remain. • Effectiveness is diminished because reducing agent is less able to be transported downgradient by groundwater to areas requiring treatment.	• Risks related to ingestion of groundwater will remain for decades following in situ treatment. Risks related to volatilization of VOCs to indoor air are less likely to remain. • Effectiveness is enhanced because the biological substrate is soluble and can be transported by groundwater to downgradient areas requiring treatment.	• Risks related to ingestion of groundwater will remain for decades once the groundwater collection system remediates the highest concentrations of CVOCs in groundwater. MNA remediation of the remaining plume is anticipated to take numerous additional years. Risks related to volatilization of VOCs to indoor air are less likely to remain following active groundwater collection and treatment.	• Risks related to ingestion of groundwater will remain for years once the groundwater collection system remediates CVOCs in groundwater to MCLs. MNA remediation of the remaining plume is anticipated to take numerous additional years. Risks related to volatilization of VOCs to indoor air are less likely to remain following active groundwater collection and treatment.	• Risks related to ingestion of groundwater will remain for decades once the groundwater in situ treatment system remediates the highest concentrations of CVOCs in groundwater. MNA remediation of the remaining plume is anticipated to take numerous additional years. Risks related to volatilization of VOCs to indoor air are less likely to remain following in situ treatment.
(b) Adequacy and reliability of controls	• Not applicable.	• Requires reliance on institutional controls to prevent use of groundwater. Also requires installation and maintenance of vapor control systems for all buildings placed over the plume. The reliability of these systems is expected to be good if properly maintained. These controls will be necessary for decades under this alternative.	• Requires reliance on institutional controls to prevent use of groundwater. These controls may be necessary for years under this alternative.	• Requires reliance on institutional controls to prevent use of groundwater. These controls will be necessary for years under this alternative.	• Requires reliance on institutional controls to prevent use of groundwater during remediation. These controls will be necessary for years under this alternative.	• Requires reliance on institutional controls to prevent use of groundwater during remediation.	• Requires reliance on institutional controls to prevent use of groundwater during remediation.
4. Reduction of Toxicity, Mobility, or Volume through Treatment							
(a) Treatment process used	• Not applicable.	• Natural attenuation only.	• TCE, cis-1,2-DCE, and vinyl chloride concentrations are reduced as contaminated groundwater flows through the treatment barriers. Reduction in concentrations take place through chemically accelerated reductive dechlorination.	• TCE, cis-1,2-DCE, and vinyl chloride concentrations are reduced as the native biomass is enhanced. Reductions in CVOC concentrations take place through biologically accelerated reductive dechlorination.	• This alternative will extract groundwater in areas of the plume exceeding 1 mg/L total CVOCs and pump the water to the onsite treatment system. • The onsite treatment system will remove CVOCs using GAC.	• Will extract groundwater in areas of the plume exceeding compound specific MCL. • VOCs would be treated using GAC.	• Will treat contaminated groundwater by heating the subsurface generating steam to volatilize the CVOCs. Offgas is extracted using SVE and, if necessary, treated prior to discharge.
(b) Degree and quantity of TMV reduction through Treatment	• Not applicable.	• Reduction of CVOC concentrations to PRGs using natural attenuation alone would take decades.	• Groundwater with total CVOC concentrations greater than 1 mg/L would be targeted. An estimated CVOC (TCE, cis-1,2-DCE, and vinyl chloride) mass of 5,300 lbs would be partially to completely dechlorinated as groundwater comes into contact with the treatment barriers.	• Groundwater with total CVOC concentrations greater than 1 mg/L would be targeted. An estimated CVOC (TCE, cis-1,2-DCE, and vinyl chloride) mass of 5,300 lbs would be partially to completely dechlorinated as groundwater came into contact with the treatment zones.	• Groundwater with total CVOC concentrations greater than 1 mg/L would be targeted for extraction and treatment. An estimated CVOC (TCE, cis-1,2-DCE, and vinyl chloride) mass of 5,300 lbs would be collected and treated.	• Would remove VOCs in the groundwater. An estimated CVOC (TCE, cis-1,2-DCE, and vinyl chloride) mass of 5,500 lbs would be collected and treated.	• Would remove a majority of the CVOCs from the groundwater. An estimated CVOC (TCE, cis-1,2-DCE, and vinyl chloride) mass of 5,300 lbs would be destroyed. • MNA would treat the remaining CVOCs over a period of years.

TABLE 5-4
Detailed Evaluation of Groundwater Media Alternatives
OMC Plant 2 Site, Feasibility Study Report

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(c) Irreversibility of TMV reduction	• Not applicable.	• Natural degradation of VOCs is irreversible.	• Chemical reduction and accelerated biodegradation of the VOCs is irreversible.	• Enhanced biodegradation of VOCs is irreversible.	• Activated carbon removes the VOCs from the extracted groundwater by adsorption, which is reversible. However activated carbon will be re-generated through incineration which destroys the CVOCs and is irreversible. • Natural biodegradation of the remaining VOCs in the plume is irreversible.	• Activated carbon removes the VOCs from the extracted groundwater by adsorption, which is reversible. However activated carbon will be re-generated through incineration which destroys the CVOCs and is irreversible.	• Volatilization of the VOCs from the groundwater and biological treatment of the VOCs in the groundwater is irreversible. The SVE offgases would be treated either through catalytic oxidation, which is irreversible, or through GAC which is irreversible when the GAC is regenerated.
(d) Type and quantity of treatment residuals	• None, because no treatment included.	• None.	• None.	• None.	• About 10,000 lbs/year of granular activated carbon is generated as a result of treatment.	• About 10,000 lbs/year of granular activated carbon is generated as a result of treatment.	• Small quantities of condensate will be generated during thermal treatment. Activated carbon may be generated if GAC is used for treatment of SVE offgases.
(e) Statutory preference for treatment as a principal element	• Preference not met for groundwater because no treatment included.	• Preference not met for groundwater because no treatment beyond natural attenuation included.	• Preference met for groundwater because treatment occurs in-situ.	• Preference met for groundwater because treatment occurs in-situ.	• Preference met for groundwater because treatment occurs at the onsite treatment plant.	• Preference met for groundwater because VOCs are treated.	• Preference met for groundwater because VOCs are treated.
5. Short-Term Effectiveness							
(a) Protection of workers during remedial action	• No remedial construction, so no risks to workers.	• No remedial construction, so no risks to workers.	• Risks to workers during construction or operation of the injection system are present as a result of the potential generation and accumulation of hydrogen gas. Accumulation of hydrogen will be monitored to prevent explosive conditions in and near injection wells. The health and safety plan would also specify additional measures such as use of non-sparking tools near the wells. • Injected compounds pose little to no contact risk to implementation staff.	• No risk to workers during injection since EISB amendments are non-hazardous. • No risks to workers during MNA monitoring.	• Minimal risks to workers during construction or operation of the pumping system. Proper health and safety procedures must be followed during construction and operation.	• Minimal risks to workers during construction or operation of the pumping system. Proper health and safety procedures must be followed during construction and operation.	• Moderate risks to workers during construction or operation of the thermal treatment system due to electrical hookups at each well. Proper health and safety procedures must be followed during construction and operation. Building security would be a priority to prevent tampering.
(b) Protection of community during remedial action	• No remedial construction, so no short-term risks to community.	• No remedial construction, so no short-term risks to community.	• Minimal risks to the community during construction and injection. A majority of the work would be conducted inside the building. Operation and maintenance activities consist of periodic groundwater sampling posing little to no risk to the community.	• Minimal risks to the community during construction and injection. A majority of the work would be conducted inside the building. Operation and maintenance activities consist of periodic groundwater sampling posing little to no risk to the community.	• Minimal risks to community during construction and operation of the system. For noise, equipment will be housed within a building and will be designed to reduce noise levels.	• Minimal risks to community during construction and operation of the system. For noise, equipment will be housed within a building and will be designed to reduce noise levels.	• Minimal risks to the community during construction and operation. The system will be installed primarily inside the building and produces little to no noise.

TABLE 5-4
Detailed Evaluation of Groundwater Media Alternatives
OMC Plant 2 Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1 No Further Action	Alternative G2 MNA and Institutional Controls	Alternative G3a In-Situ Chemical Reduction (ISCR)	Alternative G3b Enhanced In Situ Bioremediation (EISB)	Alternative G4a Groundwater Collection and Treatment with MNA	Alternative G4b Groundwater Collection and Treatment to MCLs	Alternative G5 In-Situ Thermal Treatment
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts.	▪ No remedial construction, so no environmental impacts.	▪ Injection of ZVI results in reducing conditions in the groundwater. This in turn results in elevated levels of iron and manganese and may cause arsenic levels to increase in groundwater. The expected iron plumes will need to be closely monitored so that they do not increase to the point that they could discharge to the harbor. If iron plumes do discharge to harbor, the iron would oxidize at the harbor steel sheet piling walls, producing an orange-brown iron precipitate.	▪ Injection of substrates into groundwater results in reducing conditions in the groundwater. This in turn results in elevated levels of iron and manganese and may cause arsenic levels to increase in groundwater. The expected iron plumes will need to be closely monitored so that they do not increase to the point that they could discharge to the harbor. If iron plumes do discharge to harbor, the iron would oxidize at the harbor steel sheet piling walls, producing an orange-brown iron precipitate.	▪ No environmental impacts during construction or operations of the system. Onsite discharge via reinjection or to the harbor would meet all discharge limits to prevent risks to human health and aquatic life.	▪ No environmental impacts during construction or operations of the system. Onsite discharge via reinjection or to the harbor would meet all discharge limits to prevent risks to human health and aquatic life.	▪ No environmental impacts during construction or operation of the system.
(d) Time until RAOs are achieved	▪ Long-term attainment of groundwater RAOs will take decades to meet under this alternative. ▪ Other remaining RAOs are not met.	▪ Long-term attainment of groundwater RAOs will take decades to meet under this alternative.	▪ Long-term attainment of groundwater RAOs will require years to decades.	▪ Long-term attainment of groundwater RAOs will require years to decades.	▪ The RAO for treating groundwater to MCLs will be achieved in years to decades.	▪ The RAO for treating groundwater to below the PRGs will not be achieved for many years.	▪ The RAO for treating groundwater to PRGs will require years to decades.
6. Implementability							
(a) Technical feasibility	▪ No impediments.	▪ No impediments	▪ Radius of influence for injection of insoluble amendments may be limited due to aquifer pore size.	▪ Pilot testing to establish effectiveness and dosage of amendment will be necessary.	▪ No impediments.	▪ No impediments.	▪ No impediments.
(b) Administrative feasibility	▪ No impediments.	▪ No impediments.	▪ No impediments are expected.	▪ No impediments are expected.	▪ The substantive requirements for an NPDES discharge to the harbor or via reinjection will be met. The building must remain in-place to house the treatment system and extraction wells placed through the floor.	▪ The substantive requirements for discharge to the POTW will be met. The building must remain in-place to house the treatment system and extraction wells placed through the floor.	▪ The building must remain in place to house the treatment system, minimize infiltration of stormwater, and assist with SVE of offgas.
(c) Availability of services and materials	▪ None needed.	▪ None needed.	▪ Necessary engineering services and materials readily available for installation and operation of injection system.	▪ Necessary engineering services and materials readily available for installation and operation of injection system.	▪ Necessary engineering services and materials readily available for installation and operation of system.	▪ Necessary engineering services and materials readily available for installation and operation of system.	▪ Necessary engineering services and materials are readily available for installation and operation of system.
7. Total Cost	Total Capital Cost $0 Annual O&M Cost $0 Total Periodic Cost $150,000 Total Present Worth Cost $73,000	Total Capital Cost $15,000 Annual O&M Cost $96,000 Total Periodic Cost $150,000 Total Present Worth Cost $2,901,000	Total Capital Cost $7,026,200 Annual O&M Cost $95,000 Total Periodic Cost $150,000 Total Present Worth Cost $10,613,000	Total Capital Cost $4,998,600 Annual O&M Cost $95,000 Total Periodic Cost $150,000 Total Present Worth Cost $8,586,000	Total Capital Cost $2,500,000 Annual O&M Cost $424,000 Total Periodic Cost $150,000 Total Present Worth Cost $7,819,000	Total Capital Cost $3,582,900 Annual O&M Cost $509,00 Total Periodic Cost $150,000 Total Present Worth Cost $10,990,000	Total Capital Cost $13,600,000 Annual O&M Cost $9,034,000 Total Periodic Cost $30,000 Total Present Worth Cost $33,259,000

SECTION 6

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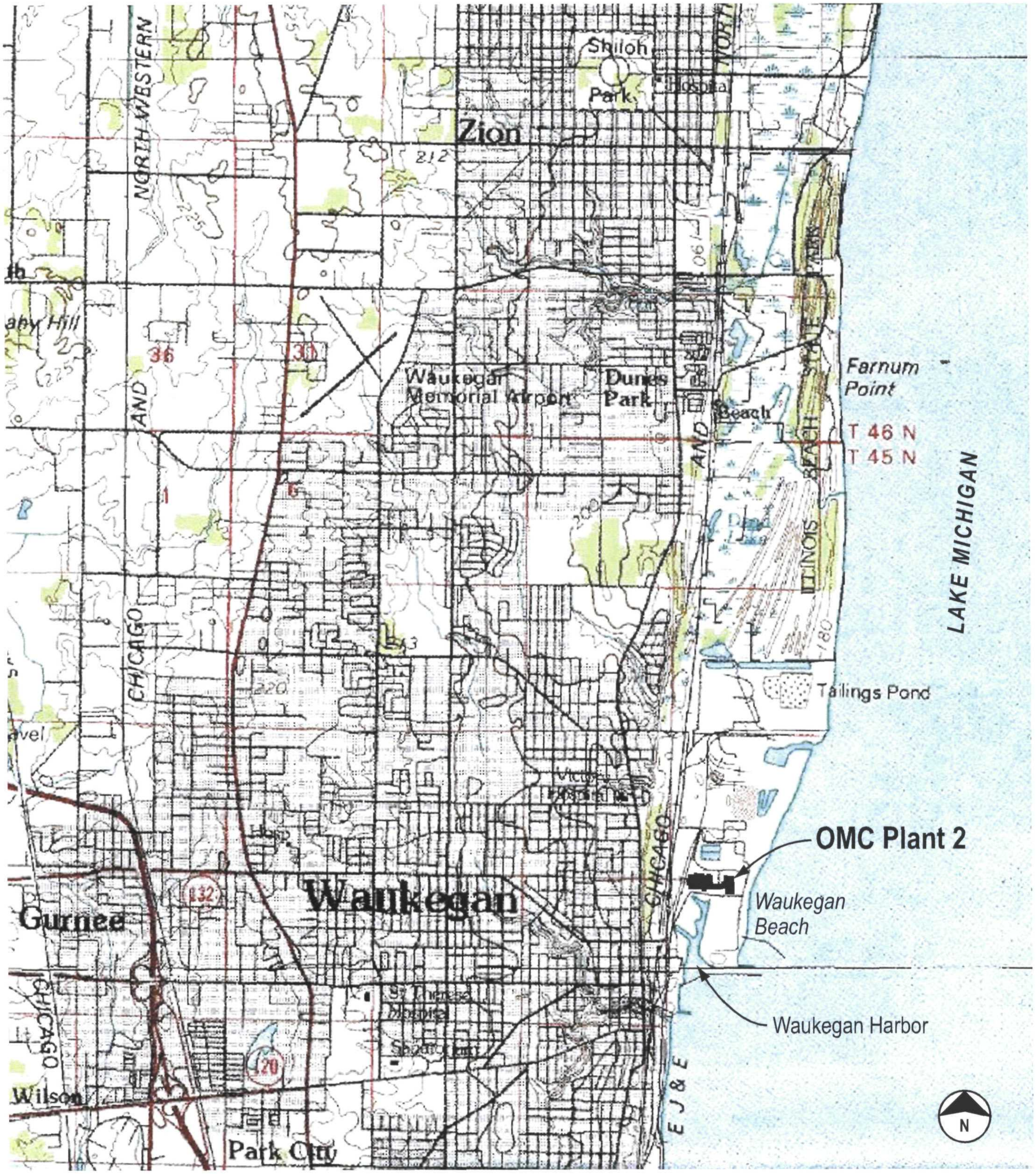
Figures



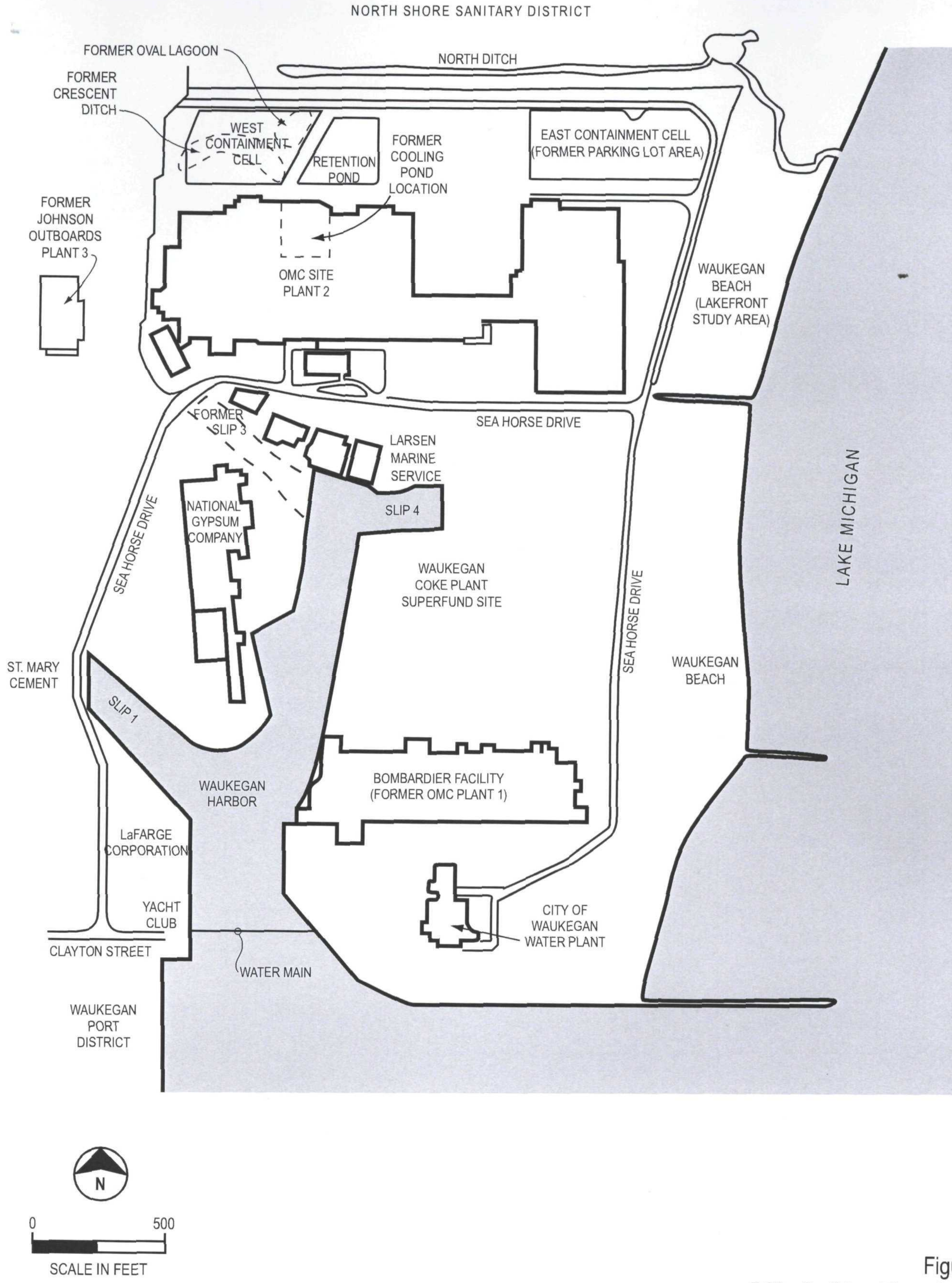
SOURCE: USGS Waukegan Quadrangle Map

0 3,000

SCALE IN FEET

Figure 1-1
Site Location Map
OMC Plant 2

CH2MHILL



SOURCE: ADAPTED FROM USEPA 2002

Figure 1-2
Vicinity Features
OMC Plant 2

E082005021MKE 186305.RS.01 Site Features_1-2_v2 3-29-06tll/jls

CH2MHILL

LEGEND

OMC Plant 2 Building Outline

North

Source:
Waukegan Lakefront-Downtown Master Plan/Urban Design Plan (Skidmore, Owings & Merrill LLP, June 23, 2003)

Figure 1-3
Plan for Harborfront and North Harbor Development Districts
OMC Plant 2

CH2MHILL

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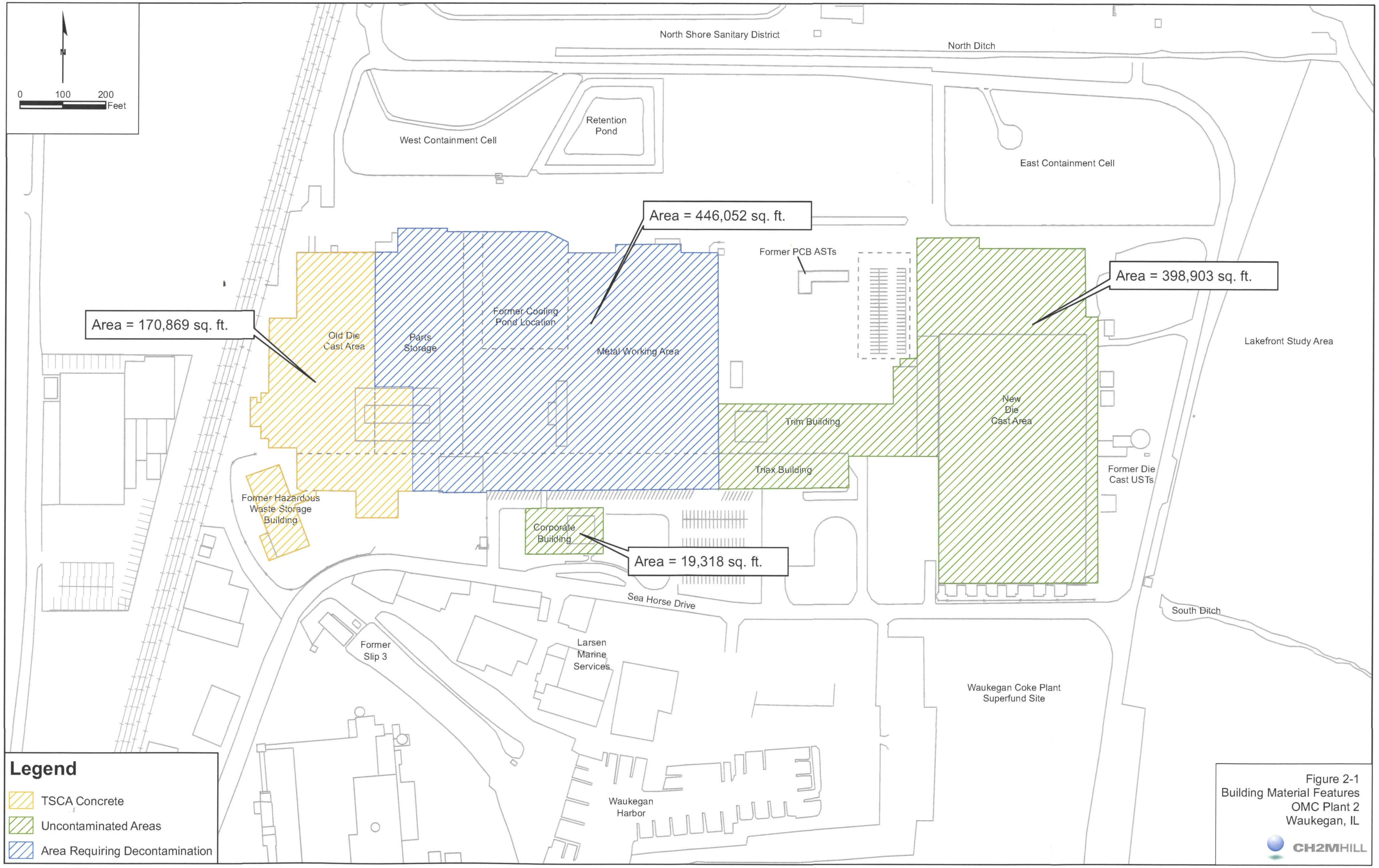

Figure 2-1
Building Material Features
OMC Plant 2
Waukegan, IL

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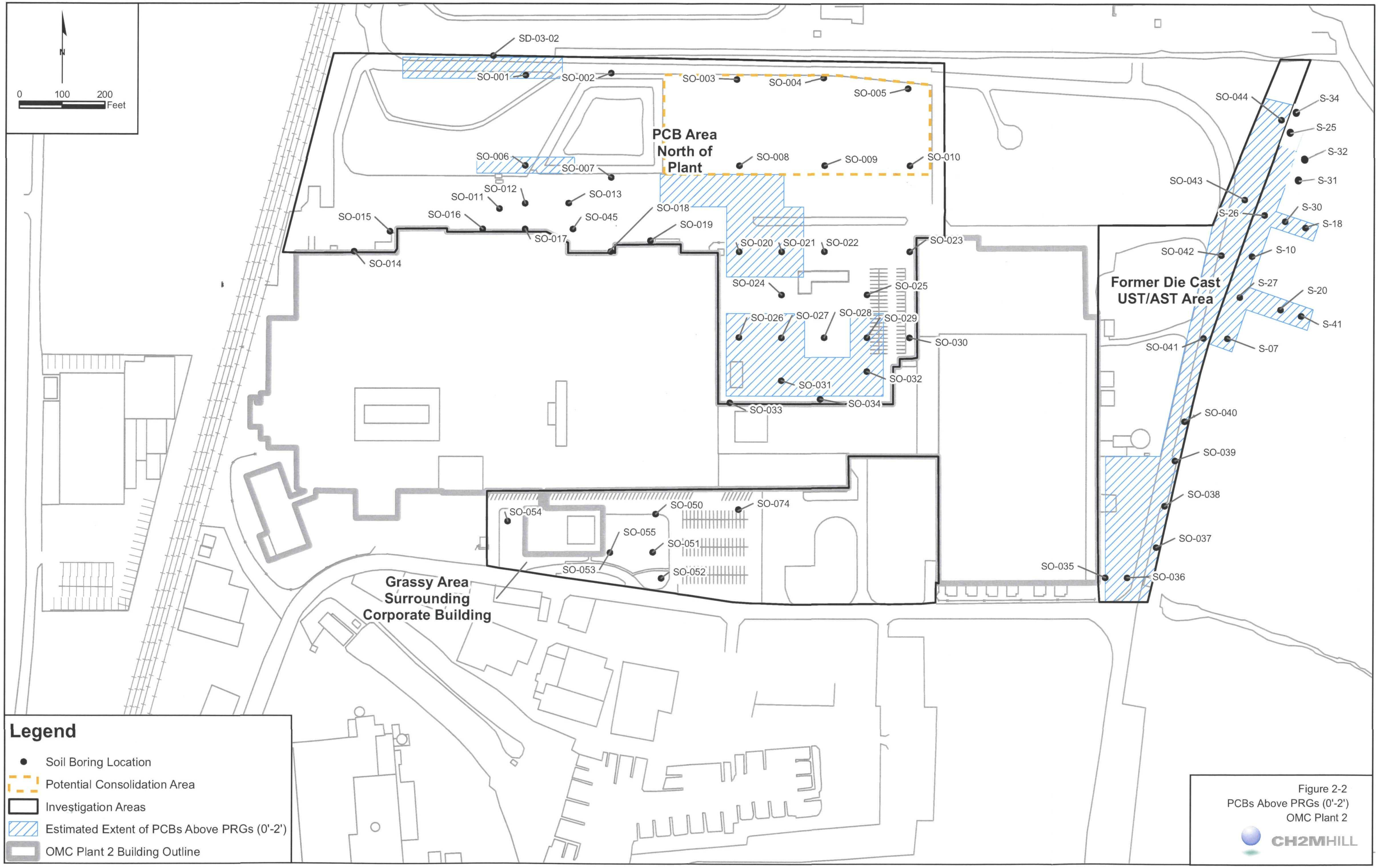

Legend

- Soil Boring Location
- Potential Consolidation Area
- Investigation Areas
- Estimated Extent of PCBs Above PRGs (0'-2')
- OMC Plant 2 Building Outline

Figure 2-2
PCBs Above PRGs (0'-2')
OMC Plant 2

CH2MHILL

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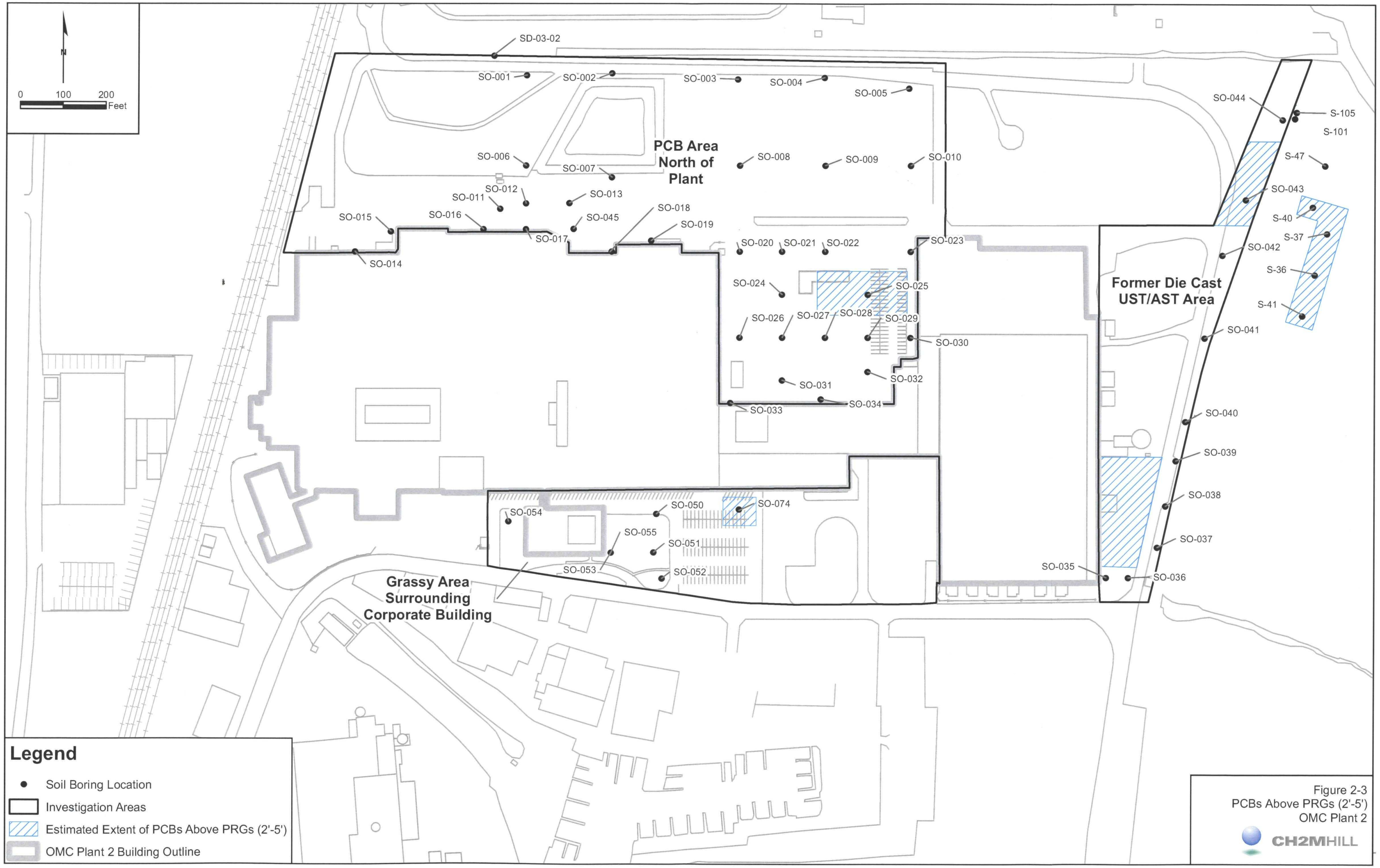

Figure 2-3
PCBs Above PRGs (2'-5')
OMC Plant 2

CH2MHILL

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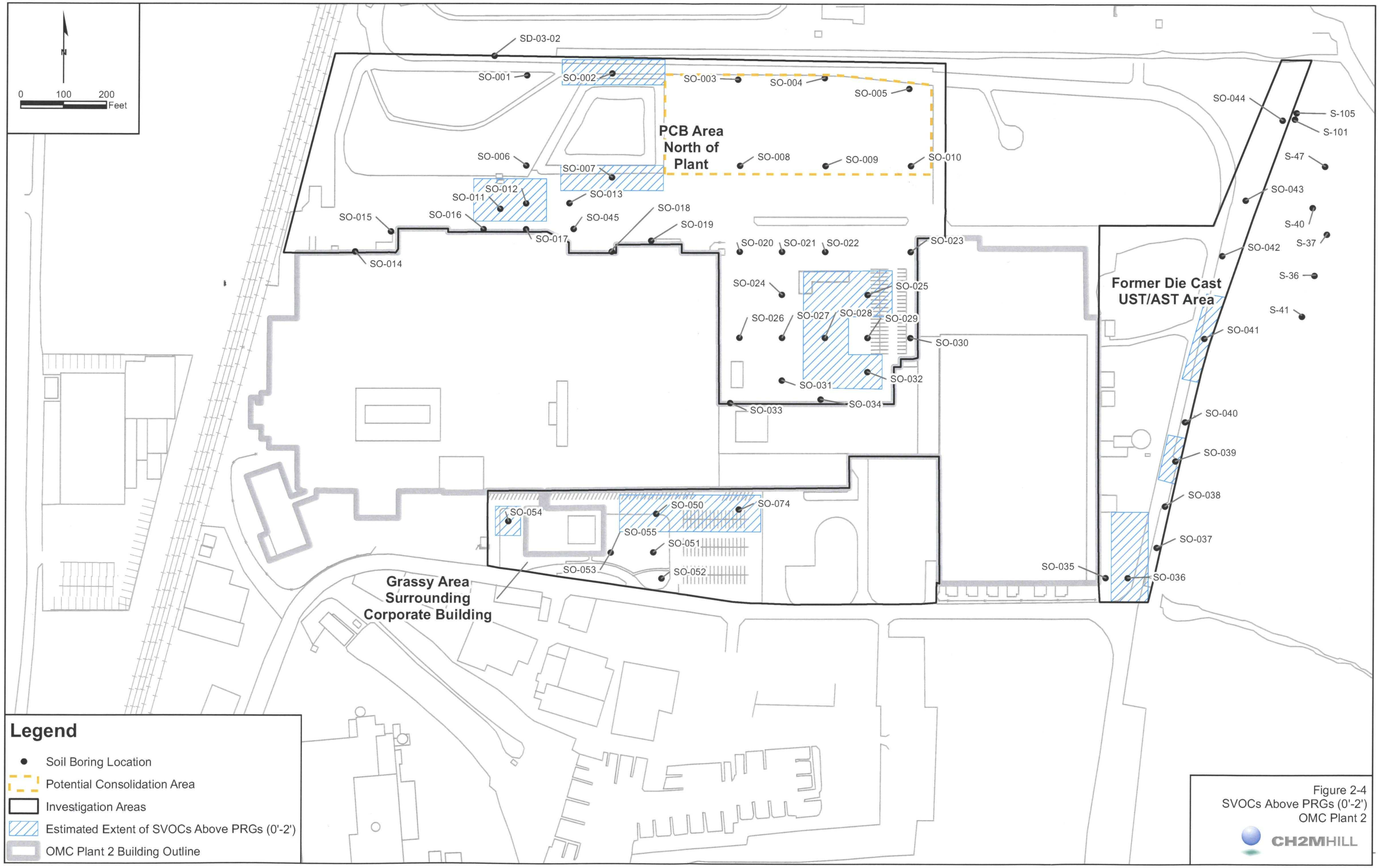

Figure 2-4
SVOCs Above PRGs (0'-2')
OMC Plant 2

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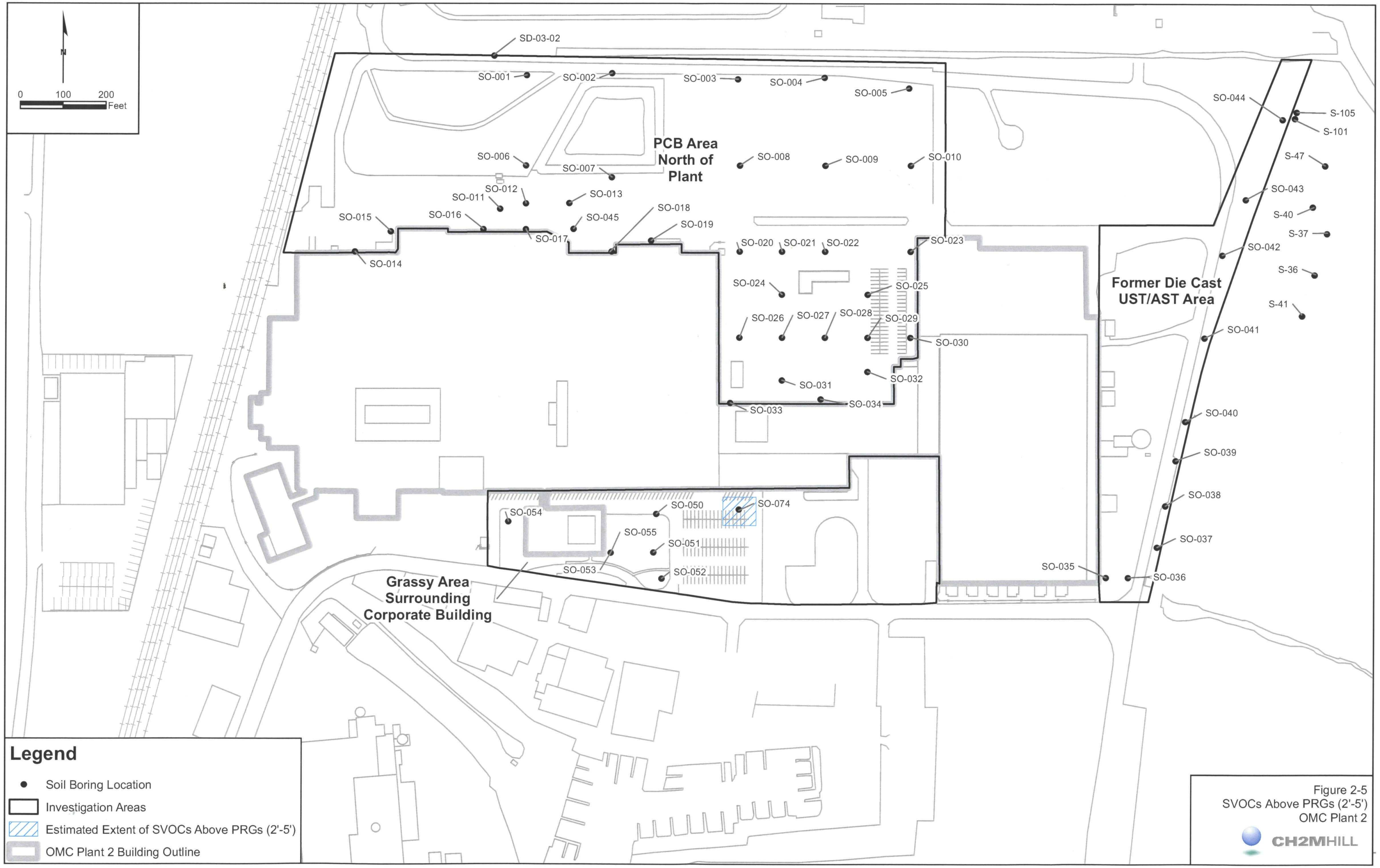

Figure 2-5
SVOCs Above PRGs (2'-5')
OMC Plant 2

CH2MHILL

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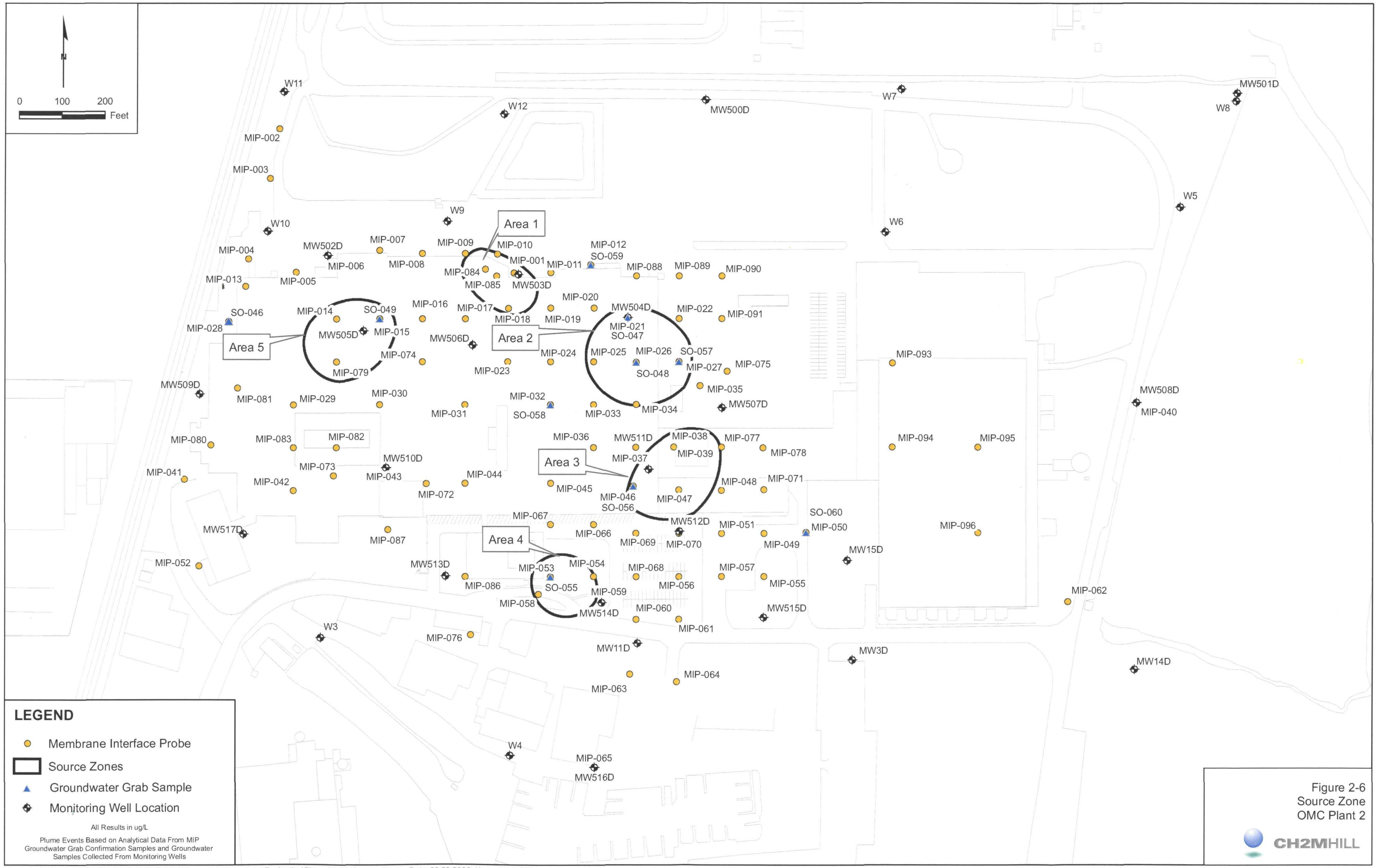

Figure 2-6
Source Zone
OMC Plant 2

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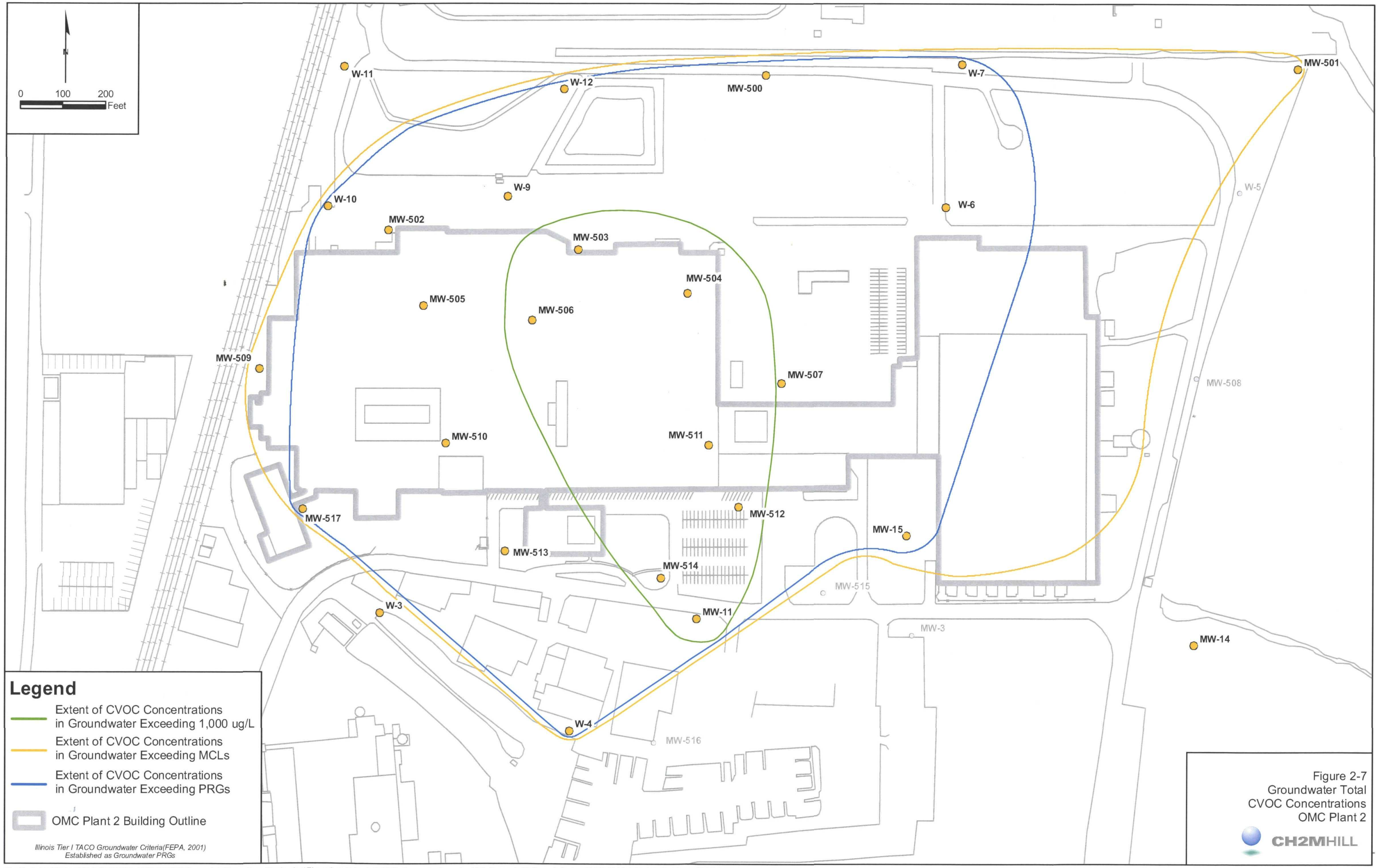

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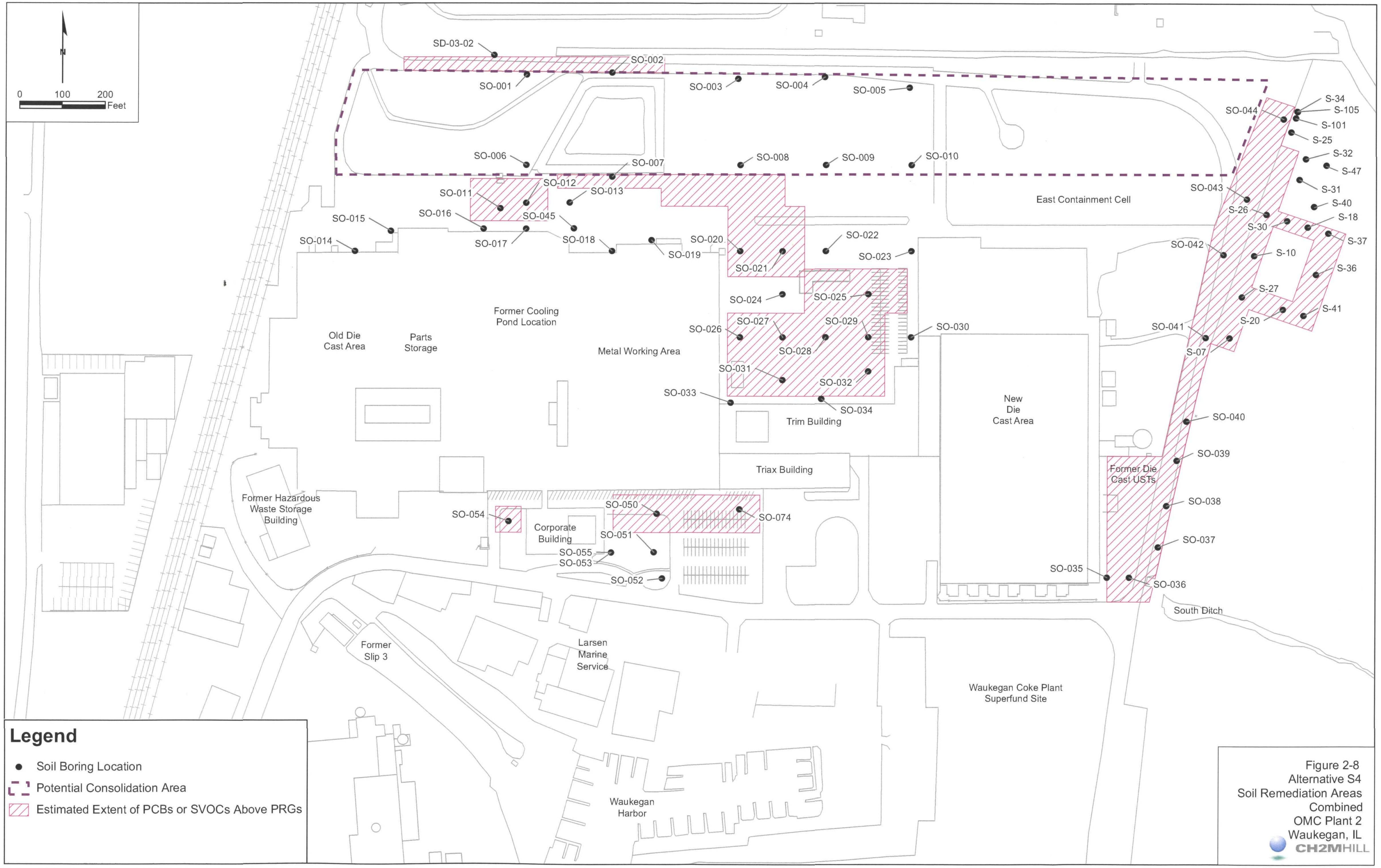

Figure 2-8
Alternative S4
Soil Remediation Areas
Combined
OMC Plant 2
Waukegan, IL

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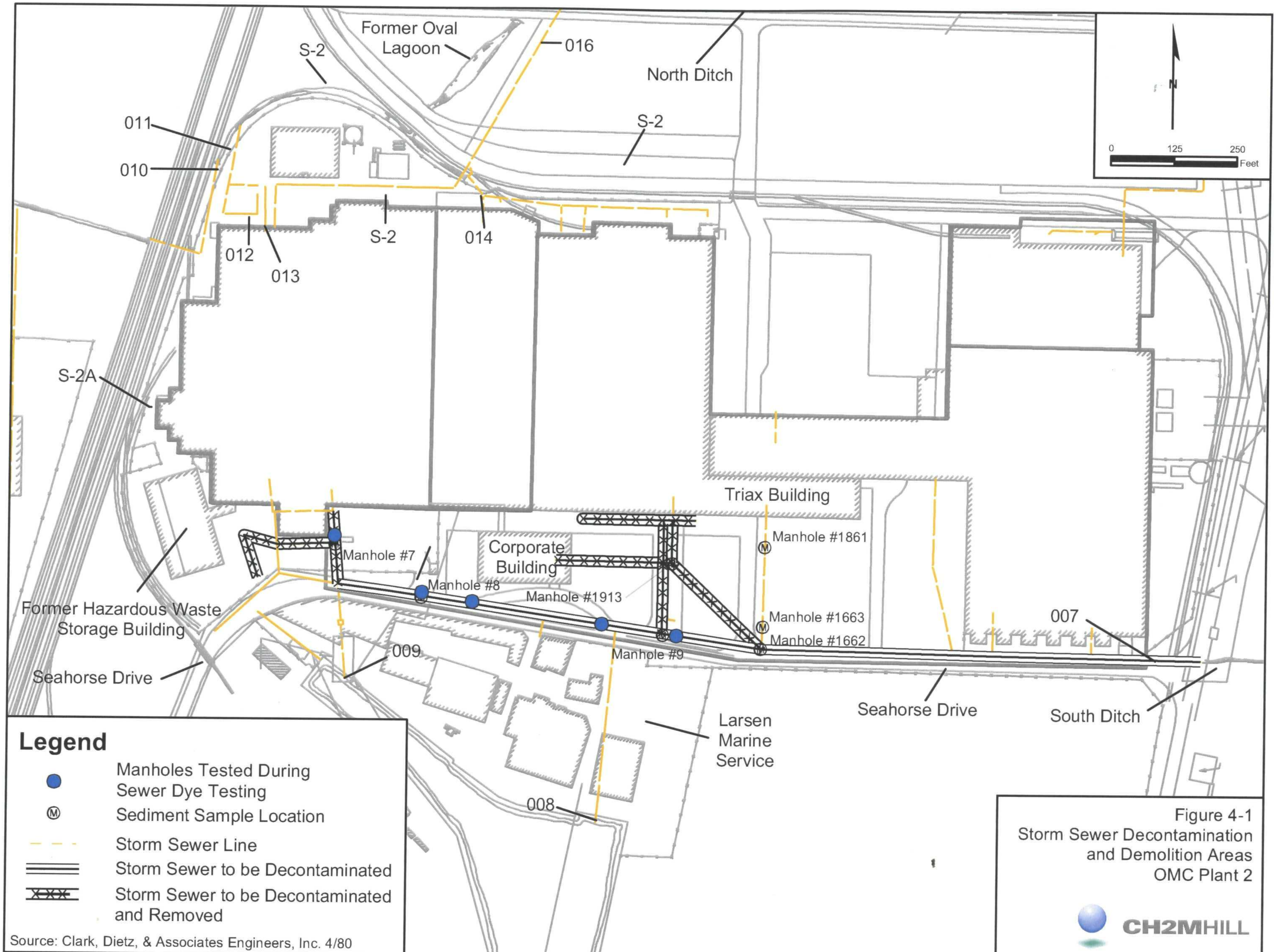

Figure 4-1
Storm Sewer Decontamination and Demolition Areas
OMC Plant 2

CH2MHILL

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LEGEND

8.7 Deep Groundwater TCE Concentrations

- - - Estimated DNAPL Extent

▲ MIP Confirmation Sample

● Deep Well Location

All Results in ug/L

Based on Analytical Data From MIP Groundwater Grab Confirmation Samples and Groundwater Samples Collected From Monitoring Wells

Figure 4-2
DNAPL Remedial Alternatives
DNAPL Treatment Zone

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APPENDIX A
ARARs
OMC Plant 2 Feasibility Study

Regulation	Requirement	ARAR Status	Analysis
Chemical-Specific ARARs			
Soil and Groundwater			
TSCA	Establishes requirements and thresholds for management of PCBs.	ARAR	TSCA is relevant and appropriate to defining the management of PCBs in soils. TSCA is applicable to remedial actions managing soils contaminated with PCBs (see action-specific ARARs).
CERCLA Guidance on Land Use in the CERCLA Remedy Selection Process	Establishes appropriate considerations in defining future land use.	TBC	Provides guidance to EPA in selecting land use for remedy selection purposes.
Illinois Administrative Code (IAC) Title 35, Part 742, Tiered Approach to Corrective Action Objectives (TACO)	TACO establishes a framework for determining soil and groundwater remediation objectives standards and for establishing institutional controls. Tier 1 remediation objectives are set at 10^{-6} ELCR and HI =1 values. Section 742.900(d) Tier 3 remediation objectives allows cleanup levels within the ELCR range of 10^{-4} to 10^{-6}.	TBC	TACO is a voluntary program and is not required (Part 742.105 (a)). It provides guidance for development of site-specific soil and groundwater remediation objectives. Will be used to establish preliminary remediation goals.
Groundwater			
Safe Drinking Water Act (SDWA)— Maximum Contaminant Levels (MCLs) 40 CFR 141.61 (organic chemicals) 40 CFR 141.62 (inorganic chemicals)	CERCLA 121(d) states that a remedial action will attain a level under the SDWA. MCLs are enforceable maximum permissible level of a contaminant which is delivered to any user of a public water system.	ARAR	MCLs are relevant and appropriate for potential drinking water sources per the NCP. Remedies may not have to demonstrate compliance with an ARAR that is technically impracticable (see NCP), such as areas of DNAPL.
SDWA—Maximum Contaminant Level Goals (MCLGs) 40 CFR 141.50 (organic chemicals) 40 CFR 141.51 (inorganic chemicals)	CERCLA 121(d)(2)(A) states that a remedial action attain MCLGs where relevant and appropriate. MCLGs are non-enforceable health goals under the SDWA.	ARAR	Non-zero MCLGs may be relevant and appropriate. MCLGs equal to zero are not appropriate for cleanup of groundwater or surface water at CERCLA sites by EPA policy (see NCP).

Regulation	Requirement	ARAR Status	Analysis
SDWA—Secondary MCLs (SMCLs) 40 CFR 143	Non-enforceable limits intended as guidelines for use by states in regulating water supplies. Secondary MCLs are related to aesthetic concerns (e.g. taste and odor) and are not health-related.	TBC	SMCLs may be considered if drinking water use of aquifer is considered feasible.
Office of Drinking Water. Drinking water health advisories.	Guidance levels for drinking water issued by Office of Drinking Water	TBC	May be used for chemicals without MCLs if groundwater is to meet drinking water quality.
IAC Title 35, Part 620 Illinois Water Quality Standards (IWQS); Part 620.210; 620.410;IWQS Class I: Potable Resource Groundwater	Groundwater must meet the standards appropriate to the groundwater class as specified in Subpart D/Section 620.401-440. Standards for potential potable water supply.	ARAR	Applicable to site groundwater. Site groundwater is a class I potable resource groundwater. Not applicable to groundwater 10 feet or less from ground surface or to groundwater from low permeability formations (k < 1 x 10-4 cm/s or <150 gpd from a well screened over 15 foot thickness). Remedies considered for the site may include development of a groundwater management zone (GMZ) which may allow contaminant concentrations higher than designated for Class I groundwater.
IAC Title 35, Part 620.220; 620.420; IWQS Class II: General Resource Groundwater	Applicable to groundwater compatible with agricultural, industrial, recreational, or beneficial uses and not in Classes I, III, or IV.	ARAR for groundwater within 10 feet of ground surface.	Not an ARAR for most of the shallow groundwater because groundwater is Class I. Applicable for groundwater 10 feet or less from ground surface.
IAC Title 35, Part 620.450(a), Alternative Groundwater Quality Standards - Groundwater Quality Restoration Standards	Applies to groundwater within a groundwater management zone. May allow concentrations higher than designated use after remediation.	ARAR	Applicable if a GMZ is used.
Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, OSWER Directive No. 9234.2-25, dated September 1993.	Applies to groundwater at contaminated sites. Establishes criteria for assessing the technical impracticability of groundwater remediation.	TBC	Groundwater in area of DNAPL may make groundwater restoration technically impracticable.

Regulation	Requirement	ARAR Status	Analysis
Surface Water			
Federal Water Pollution Control Act as amended by the Clean Water Act of 1977, Section 208(b) 40 CFR Part 131–Water Quality Standards	Establishes water quality criteria for specific pollutants for the protection of human health and aquatic life. These federal water quality criteria are non-enforceable guidelines used by the state to set water quality standards for surface water.	TBC	Water quality criteria are TBCs used in setting standards for discharges to surface water from a treatment system.
40 CFR Part 132	40CFR Part 132 provides guidance for setting discharge limits for bioaccumulative contaminants such as PCBs.	TBC	Water quality criteria are TBCs used in setting standards for discharges to surface water from a treatment system. Discharge limits for PCBs will likely be set at nondetectable levels.
Pretreatment Standards 40 CFR403	Pretreatment standards for the control of pollutants discharged to POTWs. The POTW should have either an EPA approved program or sufficient mechanism to meet the requirements of the national program in accepting CERCLA waste.	Possible ARAR	ARAR if groundwater is discharged to the Northshore Sanitary District POTW.
Great Lakes Initiative (GLI), Clean Water Act 33 U.S.C. §§1251-1387 at 33 U.S.C. 1268, as amended by the Great Lakes Critical Programs Act (Public Law 101-546)	GLI establishes water quality standards, antidegradation policies, and implementation procedures with which state standards must comply for waters in the Great Lakes System.	ARAR	GLI establishes the basis for Illinois State Standards for Lake Michigan water quality.
IAC Title 35, Part 302, Illinois Water Quality Standards General Use - Subpart B Sections 302.201-212	Section 11 of Environmental Protection Act – Regulations to restore, maintain, and enhance purity of the water of the state. Waters of state for which there is no specific designation • acute standards apply within mixing zone • chronic apply after mixing zone	ARAR	Apply to Illinois surface waters that do not have a specific use category.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Part 302, Public and food processing water supply—Subpart C; Sections 302.301-305	Applies to waters of state designated for waters drawn for treatment and distribution as a potable supply or food processing at the point of withdrawal.	ARAR	For Lake Michigan at point of water withdrawal
IAC Title 35, Part 302, Subpart E: Lake Michigan Water Quality Standards. Section 302.501-509.	Applicable to waters of Lake Michigan and the Lake Michigan Basin.	ARAR	Subpart E is for Lake Michigan. Lake Michigan Basin standards are applicable to the harbor and lake adjacent to the site.
IAC Title 35, Part 303, Subpart C: Specific Use Designations and Site Specific Water Quality Standards, Section 303.443.	Defines standards for "open waters" and "other waters" of the Lake Michigan Basin.	ARAR	Lake Michigan Basin standards are applicable to the harbor and lake adjacent to the site.
IAC Title 35, Part 304 Effluent Standards	Designates specific effluent limits for discharges to surface water.	Possible ARAR	ARAR if remedial alternative includes discharge to surface water. Substantive requirements must be met for discharges to surface water of treatment system water.
IAC Title 35, Part 309 Permits	Designates process used in setting NPDES effluent limits for discharges to surface water.	Possible ARAR	ARAR if remedial alternative includes discharge to surface water. Substantive requirements must be met for discharges to surface water of treatment system water.
IAC Title 35, Part 307 Sewer Discharge Criteria, 1101-1103 General and Specific Pretreatment Requirements.	Designates general requirements for discharges to POTWs such as no discharge of pollutants which pass through the POTW or interfere with the operation and performance of the POTW. Also gives specific limits for discharge of certain pollutants.	Possible ARAR	ARAR if remedial alternative includes discharge to POTW. Substantive requirements must be met for discharges to Northshore Sanitary District POTW of treatment system water.
IAC Title 35, Part 310 Pretreatment Programs. 310.201-202.	Designates general requirements for discharges to POTWs such as no discharge of pollutants which pass through the POTW or interfere with the operation and performance of the POTW. Also requires POTWs to develop Pretreatment programs.	Possible ARAR	ARAR if remedial alternative includes discharge to POTW. Used by Northshore Sanitary District in setting pretreatment discharge requirements for discharge of treatment system water.

Regulation	Requirement	ARAR Status	Analysis
Air			
IAC Title 35, Subtitle B: Air Pollution	Regulations contain specific requirements that pertain to allowable emissions of criteria pollutants from a number of air contaminant source categories and processes.	Possible ARAR	ARAR if remedial alternative results in air emissions. Substantive requirements for air emission control must be met.
IAC Title 35, Part 212 Visible and Particulate Matter Emissions	Regulations contain specific requirements that pertain to allowable emissions of fugitive particulate matter.	ARAR	Dust control must be implemented to control visible particulate emissions during construction activities.
IAC Title 35, Part 245 Odors	Regulations specify how to determine whether a nuisance odor is present.	ARAR	Odor control may be necessary if it is determined that a nuisance odor is present.
Location-Specific ARARs			
Coastal Zone Management Act 16 USC §1451 et. seq. 15 CFR 930	Requires that Federal agencies conducting activities directly affecting the coastal zone conduct those activities in a manner that is consistent, to the maximum extent practicable, with approved State coastal zone management programs.	ARAR	Applicable to construction in the coastal zone.
Endangered Species Act of 1973 16 USC §1531 et seq. 50 CFR 200	Requires that Federal agencies insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	ARAR	In the future redevelopment scenario, potential risks to threatened and endangered plant species that may colonize created habitat are present. Risks are a result of the current concentrations of SVOCs and PAHs in soil.
Rivers and Harbors Act of 1899 Section 10 (33 USC §401et. seq.) 33 CFR 403 33 CFR 322	Requires approval from USACE for dredging and filling work performed in a navigable waterway of the U.S. Activities that could impede navigation and commerce are prohibited.	Not likely ARAR	Dredging or filling are not likely components of remedial alternatives at OMC Plant 2.

Regulation	Requirement	ARAR Status	Analysis
National Historical Preservation Act 16 USC §661 et seq. 36 CFR Part 65	Establishes procedures to provide for preservation of scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. If scientific, historical, or archaeological artifacts are discovered at the site, work in the area of the site affected by such discovery will be halted pending the completion of any data recovery and preservation activities required pursuant to the act and its implementing regulations.	Not likely ARAR	May be ARAR during the remedial activities if scientific, historic, or archaeological artifacts are identified during implementation of the remedy.
Protection of Wetlands—Executive Order11990 50 CFR Part 6, Appendix A	Requires actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If none is available, effects from implementing the chosen alternative must be mitigated. Public notice and review of activities involving wetlands is required.	ARAR	The ecological risk assessment concluded that wetlands or aquatic habitat are not present onsite. Small wetlands were identified along the north and south ditches between the site and Lake Michigan.
Executive Order 11988 50 CFR Part 6, Appendix A	Requires actions to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains.	TBC.	Site not within floodplain.
Great Lakes Water Quality Initiative Part 132, Appendix E	Provides guidance to Great Lakes states regarding wastewater discharge, stating that lowering of water quality standards via wastewater discharge should be minimized.	TBC	Considered as guidance.
Rivers and Harbors Act. 33 CFR Part 332, Section 10.	A permit is required for work in or affecting navigable waters of the U.S. This includes dredging, disposal of fill material, filling or modification of said waters below the ordinary high water level (OHWL).	Not likely ARAR	Remedial actions are not likely to include activities within harbor or Lake Michigan.

Regulation	Requirement	ARAR Status	Analysis
Action-Specific ARARs/TBC			
Fish and Wildlife Coordination Act (16 USC 661 et seq.)	The Act provides protection and consultation with the U.S. Fish and Wildlife Service and state counterpart for actions that would affect streams, wetlands, other water bodies, or protected habitats. Action taken should protect fish or wildlife, and measures should be developed to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies that may affect the drainage ditches.
Occupational Safety and Health Act (29 U.S.C. 61 et seq.)	The Occupational Safety and Health Act was passed in 1970 to ensure worker safety on the job. The U.S. Department of Labor oversees the Act. Worker safety at hazardous waste sites is specifically addressed under 29 CFR 1910.120: Hazardous Waste Operations and Emergency Response; general worker safety is covered elsewhere within the law.	ARAR	The Act is considered an ARAR for construction activities performed during the implementation of remedies.
Clean Air Act; National Ambient Air Quality Standards (NAAQS) Section 109 40 CFR 50-99	The Clean Air Act is intended to protect the quality of air and promote public health. Title I of the Act directed the USEPA to publish national ambient air quality standards for "criteria pollutants." USEPA also has provided national emission standards for hazardous air pollutants under Title III of the Clean Air Act. Hazardous air pollutants are designated hazardous substances under CERCLA. The Clean Air Act amendments of 1990 greatly expanded the role of National Emission Standards for Hazardous Air Pollutants by designating 179 new hazardous air pollutants and directed USEPA to attain maximum achievable control technology standards for emission sources. Such emission standards are potential ARARs if remedial technologies (such as incinerators or air strippers) produce air emissions of regulated hazardous air pollutants. Specifies requirements for air emissions such as particulates, sulfur dioxide, VOCs, hazardous air pollutants, and asbestos.	ARAR	The Act is considered an ARAR for remedies that involve creation of air emissions, such as excavation activities that might create dust or treatment systems that might emit volatile organic compounds.

Regulation	Requirement	ARAR Status	Analysis
Hazardous Materials Transportation Act; 49 CFR 100-109 Transportation of hazardous materials.	Specific DOT requirements for labeling, packaging, shipping papers, and transport by rail, aircraft, vessel, and highway.	Possible ARAR	Off-site shipment of hazardous waste may occur.
Resource Conservation and Recovery Act (RCRA), (42 U.S.C. 321 et seq.)	RCRA was passed in 1976. It amended the Solid Waste Disposal Act by including provisions for hazardous waste management. Authority for implementation of RCRA in Illinois was given to the State of Illinois. See Illinois ARARs below under Title 35 IAC Parts 720 to 730.	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for onsite ex situ treatment or offsite disposal may however be characteristic hazardous waste. See Illinois ARARs below for more details of specific requirements.
40 CFR 268 Land Disposal Restrictions	The land disposal restrictions require treatment before land disposal for a wide range of hazardous wastes.	Possible ARAR	ARAR for disposal of hazardous waste. Applicable to soils that are a characteristic hazardous waste or that contain a listed waste. Contaminated soils must meet the higher of 10× the universal treatment standard or a 90% reduction of the contaminant concentration.
Toxic Substances Control Act (TSCA) 15 U.S.C. 2601 et seq.)	The Toxic Substances Control Act, created in 1976, instituted a range of control measures, primarily record-keeping and reporting requirements, to document the production and use of hazardous chemicals, primarily polychlorinated biphenyls.	ARAR	The Act applies to remedies that involve sites with polychlorinated biphenyl contamination.
Toxic Substances Control Act (TSCA) PCB Remediation Wastes; 40 CFR 761.61	Specifies requirements for self-implementing on-site cleanup of PCB remediation waste.	TBC	Requirements are not binding on CERCLA sites (761.61 (a)(1)(ii)).
TSCA Cleanup Levels. (761.61(a)(4)	Bulk remediation waste cleanup levels are as follows: High occupancy areas- < or= 1 ppm (,< or = 10 ppm if capped with 6 inch concrete or asphalt or 10 inches compacted soil); Low occupancy areas- < or = 25 ppm Non-porous surfaces cleanup levels are: High occupancy areas- < or = 10 ug/100cm^2 Low occupancy areas- < 100 ug/100cm^2 Porous surfaces Same as bulk remediation wastes	TBC	Requirements are not binding on CERCLA sites (761.61 (a)(1)(ii)).

Regulation	Requirement	ARAR Status	Analysis
TSCA Site Cleanup. (761.61(a)(5)(B)(2)(iii).	Bulk remediation waste: PCBs > 50 mg/kg must be disposed of in a TSCA chemical waste landfill or a RCRA hazardous waste. PCBs < 50 mg/kg may be disposed in Subtitle D Solid Waste landfill permitted for this waste. Non-porous material: Unpainted metal structures or piping may be sold as scrap if PCBs < 10 $ug/100cm^2$. Painted non-porous material may be sold as scrap if there is no visible indications of PCB contamination and PCBs < 10 $ug/100cm^2$. Metal structures or piping can be smelted directly or disposed in a Subtitle D Solid Waste landfill permitted for this waste if PCBs > 10 $ug/100cm^2$ and < 100 $ug/100cm^2$. Metal structures or piping must be thermally treated in a scrap metal recovery oven or disposed in a Subtitle C Hazardous Waste or TSCA chemical waste landfill if PCBs > 100 $ug/100cm^2$. Metal structures or piping may be decontaminated on-site prior to sale to reduce PCB concentrations to below 100 $ug/100cm^2$. Porous material other than Floors (e.g., painted metal, concrete block walls): May be disposed onsite or in a Subtitle D Solid Waste landfill if there is no visible indications of PCB contamination and PCBs < 10 $ug/100cm^2$. If PCBs > 10 $ug/100cm^2$ and core or chip samples < 50 mg/kg waste can disposed onsite or in a Subtitle D Solid Waste landfill. If PCBs > 10 $ug/100cm^2$ and core or chip samples > 50 mg/kg waste must be disposed in a Subtitle C Hazardous Waste or TSCA chemical waste landfill.	ARAR	Excavated soils for offsite disposal with PCBs > 50 mg/kg will be disposed in accordance with these requirements. Non-porous and porous material will be disposed in accordance with TSCA requirements.

Regulation	Requirement	ARAR Status	Analysis
TSCA Performance-based Cleanup (761.61(b)(3)).	Material that has been dredged or excavated from waters of the U.S. must be managed in accordance with a permit issued under section 404 of the Clean Water Act, or the equivalent of such a permit.	Not an ARAR	Excavation or dredging of PCB contaminated sediment is not included in the OMC Plant 2 operable unit.
TSCA (40CFR 761.65) Storage for Disposal	Bulk PCB remediation waste containing > 50 mg/kg PCBs may be stored onsite for up to 180 days, provided controls are in place for prevention of dispersal by wind or generation of leachate. Storage site requirements include a foundation below the liner, a liner, a cover, and a run-on control system.	ARAR	ARAR for excavated soils with PCBs > 50 mg/kg that are stored onsite. An extension on the 180-day storage limit could be obtained if needed through a notification to EPA per 40 CFR 761.65 (a).
IAC Title 35, Environmental Protection, Subtitle B: Air Pollution	This part describes permits and emission standards to protect air quality.	ARAR	This part is considered an ARAR for remedies that involve creation of air emissions, such as excavation activities that might create dust or treatment systems that might emit volatile organic compounds.
IAC Title 35, Part 212, Subpart K, Fugitive Particulate Matter.	Site construction and processing activities would be subject to Sections 212.304 to .310 and .312 which relate to dust control.	ARAR	Remedial action may generate fugitive dust. Rules require dust control for storage piles, conveyors, on-site traffic, and processing equipment. An operating program (plan) is required and is to be designed for significant reduction of fugitive emissions.
IAC Title 35, Part 218, Organic Material Emission Standards and Limitations for the Chicago Area (includes Lake County); Subpart C: Miscellaneous Equipment; 218.141 Separation Operations	Air pollution control requirements for effluent water separator receiving effluent water with more than 200 gal/day of free-phase organic material.	Not an ARAR	Not an ARAR. On-site wastewater treatment is not likely to treat organic pure phase liquids at rates exceeding 200 gal/day.
IAC Title 35, Part 218, Organic Material Emission Standards and Limitations for the Chicago Area (includes Lake County); Subpart K: Use of Organic Material; 218.301-.303	The discharge of greater than 8 lbs/hr of VOC from any emission unit is prohibited.	Not an ARAR	Not an ARAR. The discharge of greater than 8 lbs/hr of VOC from any aspect of the remedial action is not likely.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Part 228 Asbestos	Requirements to limit asbestos emissions from a variety of sources including demolition.	Possible ARAR	Building demolition would need to consider presence of asbestos and limit emissions if present. Excavation of soil is not expected to uncover asbestos containing material.
IAC Title 35, Subtitle G: Waste Disposal, Subchapter c: Hazardous Waste Operating Requirements, Parts 720- 729.	RCRA was passed in 1976. It amended the Solid Waste Disposal Act by including provisions for hazardous waste management. The statute sets out to control the management of hazardous waste from inception to ultimate disposal. RCRA is linked closely with CERCLA, and the CERCLA list of hazardous substances includes all RCRA hazardous wastes. RCRA applies only to remedies that generate hazardous waste. IEPA has been given authorization to implement RCRA in Illinois. Standards applicable to hazardous waste generators, transporters and operators of hazardous waste treatment storage and disposal facilities.	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for onsite ex situ treatment or offsite disposal may however be characteristic hazardous waste.
IAC Title 35, Subchapter c, Hazardous waste Operating Requirements; Part 721 Identification and listing of hazardous waste.	Soils must be managed as hazardous waste if they contain listed hazardous waste or are characteristic hazardous waste. Management of treatment residuals subject to RCRA if residuals retain characteristic.	Possible ARAR	There is no documented evidence of disposal of listed hazardous waste at the site. Soil excavated for *onsite ex situ treatment or offsite* disposal may however be characteristic hazardous waste.
IAC Title 35, Subchapter c, Part 722; Standards applicable for generators of hazardous waste.	Establishes regulation covering activities of generators of hazardous wastes. Requirements include ID number, record keeping, and use of uniform national manifest.	Possible ARAR	Applicable if wastes are RCRA hazardous and go off-site.
IAC Title 35, Subchapter c, Part 723 Standards applicable for transporters of hazardous waste.	The transport of hazardous waste is subject to requirements including DOT regulations, manifesting, record keeping, and discharge cleanup.	Possible ARAR	Applicable if wastes are RCRA hazardous and go off-site.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Subchapter c, Part 724.110 to 724.119 Subpart B—General Facility Standards.	General requirements and application of section 264 standards.	Not likely an ARAR	Applicable if A RCRA hazardous waste disposal facility is constructed onsite.
IAC Title 35, Subchapter c, Part 724.190 to 724.201 Subpart F—Releases from Solid Waste Management Units.	Requirements for wastes contained in solid waste management units.	TBC	Investigation and remediation is performed under the USEPA Superfund program with RCRA requirements for SWMUs as TBCs.
IAC Title 35, Subchapter c, Part 724.210 to 724.220 Subpart G—Closure and Post-closure	General closure and post-closure care requirements. Closure and post-closure plans (including operation and maintenance), site monitoring, record keeping, and site use restriction.	TBC	RCRA is not an ARAR for closure of site because site is not a RCRA hazardous waste treatment, storage or disposal facility. Hazardous wastes are not known to be present onsite.
IAC Title 35, Subchapter c, Part 724.270 to 724.279 Subpart I–Use and Management of Containers	Standards applicable for owners and operators of hazardous waste facilities that store containers of hazardous waste.	Possible ARAR	ARAR if remedy uses containers for storage of hazardous waste.
IAC Title 35, Subchapter c, Part 724.290 to 724.300 Subpart J–Tank Systems	Standards applicable for owners and operators that use tank systems for storing or treating hazardous waste.	Possible ARAR	ARAR if remedy uses tanks for storage of hazardous waste such as liquids which exceed TCLP limits.
IAC Title 35, Subchapter c, Part 724.320 to 724.332 Subpart K–Surface Impoundments	Standards applicable for owners and operators that use surface impoundments to treat, store or dispose of hazardous waste.	Not a likely ARAR	Surface impoundments are not likely a remedial action.
IAC Title 35, Subchapter c, Part 724.350 to 724.359 Subpart L—Waste Piles	Requirements for hazardous waste kept in piles. Requirements include liner, leachate collection unless in a container or structure.	Not likely an ARAR	Waste piles are not likely a remedial action.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Subchapter c, Part 724.370 to 724.383 Subpart M–Land Treatment	Standards applicable for owners and operators of facilities that treat or dispose of hazardous waste in land treatment units.	Not likely an ARAR	Land treatment is not likely a remedial action.
IAC Title 35, Subchapter c, Part 724.400 to 724.417 Subpart N–Landfills	Regulations for owners and operators of facilities that dispose of hazardous waste in landfills. Requirements for design, operation, and maintenance of hazardous waste landfills.	Not likely an ARAR	Not an ARAR. Landfill not a likely remedial action.
IAC Title 35, Subchapter c, Part 724.440 to 724.451 Subpart O–Incinerators	Standards applicable for owners and operators of hazardous waste incinerators.	Not likely an ARAR	On-site incineration is not a likely remedial action.
IAC Title 35, Subchapter c, Part 724.650 to 724.655 Subpart S–Special Provisions for Cleanup	Standards applicable for corrective action management units, temporary units and staging piles.	ARAR	Staging piles or temporary units may be needed for soil that may be a characteristic hazardous waste.
IAC Title 35, Subchapter c, Part 724.700 to 724.703 Subpart X–Miscellaneous Units	Standards applicable for owners and operators that treat, store or dispose of hazardous waste in miscellaneous units.	Not likely an ARAR	Other units for treatment, storage or disposal of hazardous waste are not likely to be a part of remedial actions.
IAC Title 35, Subchapter c, Part 728	Identifies land disposal restrictions and treatment requirements for materials subject to restrictions on land disposal. Must meet waste-specific treatment standards prior to disposal in a land disposal unit.	Possible ARAR	ARAR for disposal of hazardous waste. Applicable to soils that are a characteristic hazardous waste or that contain a listed waste. Contaminated soils must meet the higher of 10 x the universal treatment standard or a 90% reduction of the contaminant concentration.
IAC Title 35, Environmental Protection, Subtitle G: General Provisions, Chapter I: Pollution Control Board, Subchapter d: Underground Injection Control and Underground Storage Tank Programs; Part 730 and 738	Underground injection control and underground storage tank programs.	ARAR	These regulations would be an ARAR for remedies involving use of wells for injection of materials to accelerate remediation or reinjection of treated groundwater, remedies that require installation of an underground storage tank or remedies that reinject treated water.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Subtitle G: Subchapter f: Part 740 Site Remediation Program,	Presents requirements for the site remediation program.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105-Applicability).
IAC Title 35, Subtitle G: Subchapter f: Site Remediation Program, Section 740.530 Establishment of Groundwater Management Zones.	Presents requirements for establishment of groundwater management zones (GMZ). GMZs are three dimensional areas where groundwater exceeds the groundwater standards of 35 IAC Part 620.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105-Applicability).
IAC Title 35, Subtitle G: Subchapter f: Site Remediation Program, Section 740.535 Establishment of Soil Management Zones.	Presents requirements for establishment of soil management zones (SMZ). SMZs can be used for onsite placement of contaminated soils for structural fill or land reclamation or consolidation of contaminated soils within a remediation site. Soil with contaminants exceeding criteria cannot be placed in areas of soil meeting criteria.	TBC	The Illinois site remediation program requirements under Part 740 are specifically excluded for sites on the NPL (740.105-Applicability).
IAC Title 35, Subtitle G: Subchapter f: Part 742. Tiered Approach to Remedial Action Objectives.	The purpose of this part is to establish the procedures for investigative and remedial activities at sites where there is a release, threatened release, or suspected release of hazardous substances, pesticides, or petroleum, and for the review of those activities; establish procedures to obtain IEPA review and approval of remediation costs for the environmental remediation tax credit; and establish and administer a program for the payment of remediation costs as a brownfield site. Presents requirements for the tiered approach to corrective action objectives (TACO). Tier 1 remediation objectives are set at 10-6 ELCR and HI =1 values. Section 742.900(d) Tier 3 remediation objectives allows cleanup levels within the ELCR range of 10^{-4} to 10^{-6}.	TBC	TACO is a voluntary program and is not required (Part 742.105 (a)). Provides guidance for development of site-specific soil and groundwater remediation objectives. Will be used to establish preliminary remediation goals.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Subtitle G: Subchapter f: Tiered Approach to Remedial Action Objectives. Subpart J Institutional Controls, Part 742.1000 to 742.1020.	Provides requirements for when ICs are needed and presents requirements for implementation of ICs. ICs are needed when land use is assumed to be industrial or commercial, risk exceeds a HI = 1 or ELCR > 1 x 10-6, engineered barriers are used, exposure routes are excluded or when the point of exposure requires control.	TBC	Provides guidance for development of ICs. TACO is a TBC since it is not required.
IAC Title 35, Subtitle G: Subchapter f: Tiered Approach to Remedial Action Objectives. Subpart J Engineered Barriers, Part 742.100 to 742.1105.	Provides requirements for engineered barriers. Barriers include the following: Soil component of groundwater pathway: 1) caps or walls consisting of clay, asphalt, or concrete 2) permanent structures such as buildings, or highways. Soil ingestion pathway: 1) caps or walls consisting of clay, asphalt, or concrete, 2) permanent structures such as buildings, or highways; or 3) uncontaminated soil, sand or gravel that is at least 3 feet in thickness. Soil inhalation pathway: 1) caps or walls consisting of clay, asphalt, or concrete, 2) permanent structures such as buildings, or highways; or 3) uncontaminated soil, sand or gravel that is at least 10 feet in thickness.	TBC	Provides guidance for development of ICs. TACO is a TBC since it is not required.
IAC Title 35, Subtitle G: Subchapter h; Illinois "Superfund" Program. Part 750 Illinois Hazardous Substances Pollution Contingency Plan.	Establishes requirements for investigation and remediation of sites where there has been a release or a substantial threat of a release of a hazardous substance. Parallels US EPAs Superfund program.	TBC	Not an ARAR. The Illinois Hazardous Substances Pollution Contingency Plan is applicable to State response taken at sites which are not the subject of a federal response taken pursuant to CERCLA.
IAC Title 35, Parts 807-810 Solid Waste and Special Waste Hauling	This part describes requirements for solid waste and special waste hauling. Special waste must be treated, stored or disposed at a facility permitted to manage special waste. Presents the special waste classes and the method to determine whether the solid waste is a special waste and if so, whether it is Class A (all non-Class B special wastes) or Class B (low or moderate hazard special wastes). RCRA hazardous waste is not included within the special waste classes.	ARAR	ARAR for disposal of solid waste and special waste. Contaminated soil that is not a RCRA hazardous waste would be evaluated to determine whether it is a Class A or B special waste. Offsite disposal of special waste must be at a Solid Waste landfill permitted to receive that special waste class unless IEPA specifically allows otherwise.

Regulation	Requirement	ARAR Status	Analysis
IAC Title 35, Part 811 Applies to all new landfills.	Requirements for new solid waste landfills.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart A–General Standards for All Landfills	Location standards, operating standards, closure and post-closure maintenance.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart C–Putrescible and Chemical Waste Landfills General	Location standards, liner and leachate collection system requirements, final cover requirements.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subpart C–Putrescible and Chemical Waste Landfills Facility Location (811.302)	Location of landfill including setback zone, proximity to sole source aquifer, residences, schools, hospitals or runways.	Possible ARAR	ARAR if a new solid waste landfill is a remedial action.
IAC Title 35, Subtitle H: Part 900 Noise	Regulations contain specific requirements that pertain to nuisance noise levels.	Possible ARAR	ARAR. Noise levels will need to be controlled if noise reaches nuisance levels.
Lake County Stormwater Management Commission, Watershed Development Ordinance	Regulations specify performance standards for stormwater control.	ARAR	ARAR. Remedial actions need to be evaluated relative to stormwater controls if they disturb more than 5,000 ft^2 of soil. http://www.co.lake.il.us/smc/regulatory/wdo/docs.asp

Appendix B

Detailed Cost Estimates

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site:	OMC Plant 2 Superfund Site, Waukegan, IL	**Base Year:**	2006
Location:	Building Materials Media- **Remediation to Residential PRGs**	**Date:**	12/27/2006 13:24
Phase:	Feasibility Study		

	Alternative B1 No Further Action	**Alternative B2** Demolition and Offsite Disposal	**Alternative B3** Demolition, Offsite Disposal, and Onsite Consolidation	**Alternative B4** Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
Total Project Duration (Years)	50	50	50	50
Capital Cost	$0	$13,770,000	$12,800,000	$13,250,000
Annual O&M Cost	$0	$0	$9,200	$10,500
Total Periodic Cost	$0	$0	$0	$0
Total Present Value of Alternative	$0	$13,770,000	$13,040,000	$13,520,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Alternative B1**
Name: **No Further Action**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Building Materials Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2005
Date: 12/27/2006 13 24

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Alternative					
No construction				$0	
TOTAL CAPITAL COST				$0	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$5,000	$0	
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
				Total	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$0	$0	0 71	$0	
PERIODIC COST	10	$0	$0	0.51	$0	
PERIODIC COST	15	$0	$0	0.36	$0	
PERIODIC COST	20	$0	$0	0.26	$0	
PERIODIC COST	25	$0	$0	0.18	$0	
PERIODIC COST	30	$0	$0	0.13	$0	
PERIODIC COST	35	$0	$0	0.09	$0	
PERIODIC COST	40	$0	$0	0 07	$0	
PERIODIC COST	45	$0	$0	0.05	$0	
PERIODIC COST	50	$0	$0	0.03	$0	
		$0			$0	
TOTAL PRESENT VALUE OF ALTERNATIVE					$0	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates *During the Feasibility Study*. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative B2**
Name: **Demolition and Offsite Disposal**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Building Materials Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 24

Description: Soil samples for waste characterization
Soil excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone) around perimeter of building 20 feet wide
10% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil via dump to Subtitle D (<50 ppm PCBs) or Subtitle C (>50 ppm PCBs)
Backfill of excavation to existing grade
Decontamination, Demolition, Recycling, Transportation, and Disposal of Contaminated Building Areas
Recovery value of steel and other assets assumes decontaminated
70% of material decontaminated by pressure washing, 30% requires sand blasting

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266 01	$3,266	Means 33-23-1180
TCLP VOC, SVOC, and Metal Analysis	12	EA	$1,065 35	$12,784	33-02-1705 Testing specifically for waste profiling
Excavation of Building Perimeter Soil					
Silt Fencing	7,000	FT	$3 90	$27,290	18 05 0206. Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	1,111	CY	$62 10	$68 995	17-02-0203. Break up pavement for excavation
966, 4 0 CY Wheel Loader	123	HR	$151 47	$18,700	17-03-0224 Misc soil handling
Excavation, 1 Cy Hydraulic Excavator, Med Mat'l, 40 CY/HR	11,111	CY	$6 43	$71,499	17-03-0276
Bulk Solid Waste Loading Into Truck	11,111	CY	$3 13	$34,741	33-19-0150. Load soil into dump truck
Air Monitoring Station	3	MO	$1,361 54	$3,774	33-01-0301. Perimeter air monitoring station west side
Confirmation Sampling After Soil Removal					
PID, per day	15	DAY	$179 53	$2,771	33-01-0303. Soil screening
Pesticides/PCBs Soil Analysis	282	EA	$269 30	$75,852	33-02-1717. Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	240	EA	$327 99	$78,719	33-02-1720; Confirmation Sampling
Polynuclear Aromatic Hydrocarbons, Soil Analysis	240	EA	$188 51	$45,241	33-02-1722. Confirmation Sampling
Transportation and Disposal					
Transport <50 ppm PCBs, Dump Truck, 20 T	15,000	TON	$7 60	$114,063	Onyx, <50 ppm material transportation to landfill
32 Ft Dump Truck Disposable Liner, 6 Mil	926	EA	$53 17	$49,234	33-19-0807. Liners for every load
Landfill <50 ppm PCBs Disposal/Subtitle D	15,000	TON	$20 74	$311,163	Onyx, <50 ppm material disposal at landfill
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	1,667	TON	$194 06	$323,431	EQ >50 ppm trans & disposal
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	12,222	CY	$14 42	$176,248	17-03-0423 Bring in offsite material and backfill excavation
Fine Grading	13,333	SY	$1 65	$22,013	17 03 0103. Grade material after placement
Hydroseed of Excavation Area	3	ACRE	$3,225	$8,884	CH2M HILL est
Building Decontamination					
Asbestos Survey	1	LS	$32,850 00	$32,850	ENTACT. Contaminated area only
Asbestos Removal - Pipe Insulation air cell type, over 16" diameter	5,000	LF	$5 62	$28,123	25-01-0418. CH2M HILL Est
Asbestos Removal - Collect and bag bulk material, large product loader	3,927	EA	$5 56	$21,828	25-01-0502. 3 CF per bag
Asbestos - Double Bag and Decontaminate	3,927	EA	$35 38	$138,925	25-01-0503
Asbestos - Disposal charges, not including haul, average	145	CY	$187 43	$27,261	25-01-0506/7
Pressure Wash Decontamination Internal Surfaces	1	LS	$459,900 00	$459,900	ENTACT. Contaminated area only, 70% can be pressure washed (estimated)
Sand Blast Decontamination Internal Surfaces	1	LS	$394,200 00	$394,200	ENTACT. Only for material pressure wash decon will not work/painted material - Estimated at 30%
Clean Trenches, Sumps, and Pits	1	LS	$38,325 00	$38,325	Quote from ENTACT
Clean Equipment and Machinery in Building	1	LS	$43 800 00	$43,800	Quote from ENTACT
Decontaminated Storm Sewer South Side of Building	4,320	SF	$3 25	$14,041	33-17-0813, 33-17-0815, 33-17-0817
Labor to Decontaminate Storm Sewer South Side of Building	43	HR	$86 40	$3,732	33-17-0823, 100 SF/Hour
Building Demolition					
Asset Recovery Value	1	LS	-$775,000 00	($775,000)	Quote from ENTACT; Assumes 62% of Assets in entire building is location in Contaminated Areas and all can be recovered
Steel Scrap Value	4,000	TON	-$120 00	($480,000)	Quote from ENTACT; Assumes 50% of steel in entire building is located in Contaminated Areas and all can be scrapped
Estimated Reduction in Steel Scrap Value by 2007	60	Percent		$288,000	Quote from ENTACT - Steel estimated to be reduced in scrap value by 60% by 2007
Demolition of Contaminated Areas	1	LS	$1,198,232 22	$1,198,232	Quote from ENTACT, Does not include T&D
Disposal of Construction and Demo Debris	17,196	TON	$49 55	$852,040	Quote from ENTACT. Brick, Office Materials, Unsold Items, Roofing, Assumed <50 ppm PCBs
Transportation and Disposal Demo Debris <50 ppm PCBs/Subtitle D	2,000	TON	$37 23	$74,460	Quote from ENTACT, All Material Other Than C&D Excluding Steel, Concrete, Asbestos (essentially cinder block)
Transportation and Disposal Demo Debris >50 ppm PCBs/Subtitle C	0	TON	$200 39	$0	Quote from ENTACT, Assume all C&D and cinder block is <50 ppm PCBs
Removal of Storm Sewer South Side of Building	1,375	LF	$17 98	$24,726	17-02-0301
Excavation for Removal	637	CY	$6 43	$4,096	17-03-0276
Removal of Catch Basins	9	EA	$45 03	$405	17-02-0305
Slab Demolition					
Demolition of Slab	1	LS	$499,695 59	$499,696	Quote from ENTACT - Does not include T&D
Concrete with acceptable levels for reuse	2,483	LOAD	$164 25	$407 833	Quote from ENTACT - T&D 10 tons per load
Concrete Crusher for Onsite Reuse	1	LS	$235,425 00	$235,425	Quote from ENTACT, Only for crushing and using onsite
Transportation and Disposal Concrete <50 ppm PCBs/Subtitle D	22,347	TON	$37 23	$831,979	Quote from ENTACT
Transportation and Disposal Concrete >50 ppm PCBs/Subtitle C	9,500	TON	$200 39	$1,903,658	Quote from ENTACT
Uncontaminated Building Area Demolition - NOT INCLUDED IN TOTAL COST					
Demolition of Slab	1	LS	$290,316 26	$290,316	Quote from ENTACT, Does not include T&D
Concrete with acceptable levels for reuse	2,216	LOAD	$164 25	$363,978	Quote from ENTACT - T&D 10 tons per load
SUBTOTAL				$7,717,202	
Mobilization/Demobilization	5%			$385,860	Per CCI
Subcontractor General Conditions	15%			$1,157,580	Per CCI
SUBTOTAL				$9,260,642	
SUBTOTAL				$9,260,000	
Contingency	25%			$2,315,000	10% Scope + 15% Bid
SUBTOTAL				$11,575,000	
Project Management	5%			$578,750	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	4%			$463,000	USEPA 2000, p. 5-13, $2M-$10M CH2M HILL est based on limited scope of design
Construction Management	10%			$1,157,500	USEPA 2000, p. 5-13, $2M-$10M; CH2M HILL est based on scope of construction
SUBTOTAL				$2,199,250	
TOTAL CAPITAL COST				$13,770,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	Hr	$60	$0	
SUBTOTAL				$0	
Contingency	30%			$0	10% Scope + 20% Bid
SUBTOTAL				$0	
Project Management	5%			$0	
Technical Support	10%			$0	
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
			Total		$0	
TOTAL ANNUAL PERIODIC COST					$0	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$13,770,000	$13,770,000	1 000	$13,770,000	
ANNUAL O&M COST	1 to 50	$0	$0	25 730	$0	
PERIODIC COST	5	$0	$0	0 86	$0	
PERIODIC COST	10	$0	$0	0 74	$0	
PERIODIC COST	15	$0	$0	0 64	$0	
PERIODIC COST	20	$0	$0	0.55	$0	
PERIODIC COST	25	$0	$0	0.48	$0	
PERIODIC COST	30	$0	$0	0.41	$0	
PERIODIC COST	35	$0	$0	0 36	$0	
PERIODIC COST	40	$0	$0	0 31	$0	
PERIODIC COST	45	$0	$0	0 26	$0	
PERIODIC COST	50	$0	$0	0.23	$0	
		$13,800,000			$13,770,000	
TOTAL PRESENT VALUE OF ALTERNATIVE					$13,770,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000)

Alternative Name: **Alternative B3**
Demolition, Offsite Disposal, and Onsite Consolidation

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Building Materials Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 24

Description: Soil samples for waste characterization
Soil excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone) around perimeter of building 20 feet wide
10% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil via dump to Subtitle D (<50 ppm PCBs) or Subtitle C (>50 ppm PCBs)
Backfill of excavation to existing grade
Decontamination, Demolition, Recycling, Transportation, and Disposal of Contaminated Building Areas
Handling, compaction or berm material including 1 foot thick cover (general fill)
Long term O&M/Inspections for Berm
Recovery value of steel and other assets assumes decontaminated
70% of material decontaminated by pressure washing 30% requires sand blasting

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266 01	$3,266	Means 33-23-1180
TCLP VOC, SVOC and Metal Analysis	12	EA	$1,065 35	$12,784	33-02-1705, Testing specifically for waste profiling
Excavation of Building Perimeter Soil					
Silt Fencing	7,000	EA	$3 90	$27,290	18 05 0206, Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	1,111	CY	$62 10	$66,995	17-02-0203, Break up pavement for excavation
966, 4 0 CY, Wheel Loader	123	HR	$151 47	$18 700	17-03-0224, Misc soil handling
Excavation, 1 Cy Hydraulic Excavator Med Mat'l 40 CY/HR	11,111	CY	$6 43	$71,499	17-03-0276
Bulk Solid Waste Loading into Truck	11,111	CY	$3 13	$34,741	33-19-0150, Load soil into dump truck
Air Monitoring Station	3	MO	$1,361 54	$3 774	33-01-0301, Perimeter air monitoring station west side
Confirmation Sampling After Soil Removal					
PID, per day	15	DAY	$179 53	$2,771	33-01-0303, Soil screening
Pesticides/PCBs Soil Analysis	282	EA	$269 30	$75,852	33-02-1717 Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	240	EA	$327 99	$78,719	33-02-1720, Confirmation Sampling
Polynuclear Aromatic Hydrocarbons, Soil Analysis	240	EA	$188 51	$45,241	33-02-1722, Confirmation Sampling
Transportation and Disposal					
Transport Bulk Solid Waste <50 ppm PCBs (Onsite)	750	MI	$2 58	$1,934	33-19-0205, Onsite trucking of <50 ppm material to berm area
Disposal in Berm Covered Below Under Backfill					
32 Ft Dump Truck Disposable Liner, 6 Mil	93	EA	$53 17	$4,923	33-19-0607, Liners for every load >50 ppm
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	1,667	TON	$194.06	$323,431	EQ. >50 ppm trans & disposal
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	12,222	CY	$14 42	$176,248	17-03-0423, Bring in offsite material and backfill excavation
Fine Grading	13,333	SY	$1 65	$22 013	17 03 0103 Grade material after placement
Hydroseed of Excavation Area	3	ACRE	$3,225	$8,884	CH2M HILL est
Backfill Berm with Excavated Material	11,111	CY	$6 61	$73,464	17-03-0415
Rough Grading (Berm)	16,667	SY	$5 98	$99,592	17-03-0101 Handle excavated material to rough grade
Backfill with Onsite Borrow, 6" Lifts Spreading, Compaction	5,556	CY	$12 38	$68,803	17-03-0422, 1 foot thick cover material only
Hydroseed of Berm Area	12	ACRE	$3,225	$37,943	CH2M HILL est
Building Decontamination					
Asbestos Survey	1	LS	$32,850 00	$32,850	ENTACT, Contaminated area only
Asbestos Removal - Pipe Insulation, air cell type over 16" diameter	5,000	LF	$5 62	$28,123	25-01-0418, CH2M HILL Est
Asbestos Removal - Collect and bag bulk material, large product loader	3,927	EA	$5 56	$21,828	25-01-0502, 3 CF per bag
Asbestos - Double Bag and Decontaminate	3,927	EA	$35 38	$138,925	25-01-0503
Asbestos - Disposal charges, not including haul, average	145	CY	$187 43	$27,261	25-01-0506/7
Pressure Wash Decontamination Internal Surfaces	1	LS	$459,900 00	$459,900	ENTACT, Contaminated area only; 70% can be pressure washed (estimated)
Sand Blast Decontamination Internal Surfaces	*1*	*LS*	*$394,200 00*	$394,200	ENTACT, *Only for material pressure wash decon will not work/painted material - Estimated at 30%*
Clean Trenches, Sumps, and Pits	1	LS	$38,325 00	$38,325	Quote from ENTACT
Clean Equipment and Machinery in Building	1	LS	$43,800 00	$43,800	Quote from ENTACT
Decontaminated Storm Sewer South Side of Building	4,320	SF	$3 25	$14,041	33-17-0813; 33-17-0815 33-17-0817
Labor to Decontaminate Storm Sewer South Side of Building	43	HR	$86 40	$3,732	33-17-0823, 100 SF/Hour
Building Demolition					
Asset Recovery Value	1	LS	-$775,000 00	($775,000)	Quote from ENTACT, Assumes 62% of Assetsin entire building is location in Contaminated Areas and all can be recovered
Steel Scrap Value	4 000	TON	-$120 00	($480,000)	Quote from ENTACT, Assumes 50% of steel in entire building is located in Contaminated Areas and all can be scrapped
Estimated Reduction in Steel Scrap Value by 2007	60	Percent		$288,000	Quote from ENTACT - Steel estimated to be reduced in scrap value by 60% by 2007
Demolition of Contaminated Areas	1	LS	$1,198,232 22	$1,198,232	Quote from ENTACT, Does not include T&D
Disposal of Construction and Demo Debris	17,196	TON	$49 55	$852,040	Quote from ENTACT Brick, Office Materials, Unsold Items, Roofing, Assumed <50 ppm PCBs
Transportation and Disposal Demo Debris >50 ppm PCBs/Subtitle C	0	TON	$200.39	$0	Quote from ENTACT, Assume all C&D and cinder block is <50 ppm PCBs
Transportation and Disposal Demo Debris Consolidation Onsite	2,000	TON	$16 43	$32,850	Quote from ENTACT. *All Material Other Than C&D Excluding Steel, Concrete, Asbestos (essentially cinder block)*
Concrete Crusher for Onsite Reuse of Cinder Block	1	LS	$27,381 37	$27,381	Quote from ENTACT, Proportionate cost only for crushing and using onsite
Removal of Storm Sewer South Side of Building	1,375	LF	$17 98	$24,726	17-02-0301
Excavation for Removal	637	CY	$6 43	$4,096	17-03-0276
Removal of Catch Basins	9	EA	$45 03	$405	17-02-0305
Slab Demolition					
Demolition of Slab	1	LS	$499,695 59	$499,696	Quote from ENTACT - Does not include T&D
Concrete with acceptable levels for reuse	2,483	LOAD	$164 25	$407,833	Quote from ENTACT - T&D 10 tons per load
Concrete Crusher for Onsite Reuse	1	LS	$235,425 00	$235,425	Quote from ENTACT, Only for crushing and using onsite
Transportation and Disposal Concrete >50 ppm PCBs/Subtitle C	9,500	TON	$200 39	$1,903,658	Quote from ENTACT
Transportation and Disposal Concrete Consolidation Onsite	22,347	TON	$16 43	$367,049	Quote from ENTACT
Uncontaminated Building Area Demolition - NOT INCLUDED IN TOTAL COST					
Demolition of Slab	1	LS	$290,316 26	$290,316	Quote from ENTACT Does not include T&D
Concrete with acceptable levels for reuse	2,216	LOAD	$164 25	$363 978	Quote from ENTACT - T&D 10 tons per load
SUBTOTAL				$7,050,245	
Mobilization/Demobilization	5%			$352,512	Per CCI
Subcontractor General Conditions	15%			$1,057,537	Per CCI
SUBTOTAL				$8,460,294	
SUBTOTAL				$8,460,000	
Contingency	25%			$2,115,000	10% Scope + 15% Bid
SUBTOTAL				$10,575,000	
Project Management	5%			$528,750	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	6%			$634,500	USEPA 2000, p. 5-13, $2M-$10M. CH2M HILL est based on limited scope of design
Construction Management	10%			$1,057,500	USEPA 2000, p 5-13, $2M-$10M; CH2M HILL est based on scope of construction
SUBTOTAL				$2,220,750	
TOTAL CAPITAL COST				**$12,800,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	8	Hr	$60	$480	
Cap Repair	1 0	LS	$688	$688	Assumes 1% of cover cost to repair annually
Cap Inspection and Repair Report	1 0	LS	$5,000	$5,000	Biennial Report
SUBTOTAL				$6,168	
Contingency	30%			$1,850	10% Scope + 20% Bid
SUBTOTAL				$8,018	
Project Management	5%			$401	
Technical Support	10%			$802	
TOTAL ANNUAL O&M COST Year 1 to 50				**$9,200**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
			Total		$0	
TOTAL ANNUAL PERIODIC COST					**$0**	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$12,800,000	$12,800,000	1.000	$12,800,000	
ANNUAL O&M COST - Cap	1 to 50	$460,000	$9,200	25.7	$236,714	
PERIODIC COST	5	$0	$0	0.86	$0	
PERIODIC COST	10	$0	$0	0.74	$0	
PERIODIC COST	15	$0	$0	0.64	$0	
PERIODIC COST	20	$0	$0	0.55	$0	
PERIODIC COST	25	$0	$0	0.48	$0	
PERIODIC COST	30	$0	$0	0.41	$0	
PERIODIC COST	35	$0	$0	0.36	$0	
PERIODIC COST	40	$0	$0	0 31	$0	
PERIODIC COST	45	$0	$0	0.26	$0	
PERIODIC COST	50	$0	$0	0.23	$0	
		$13,300,000			$13,036,714	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$13,040,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000).

Alternative: Alternative B4

Name: Demolition, Offsite Disposal, and Onsite Consolidation with Harbor Sediments

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Building Materials Media - Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 24

Description:
Soil samples for waste characterization
Soil excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone) around perimeter of building 20 feet wide
10% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil via dump to Subtitle D (<50 ppm PCBs) or Subtitle C (>50 ppm PCBs)
Backfill of excavation to existing grade
Decontamination, Demolition, Recycling, Transportation, and Disposal of Contaminated Building Areas
Handling, compaction or berm material including 1 foot thick cover (general fill)
Long term O&M/Inspections for Berm
Material can be placed on top of containment cells without damaging containment cells
Recovery value of steel and other assets assumes decontaminated
70% of material decontaminated by pressure washing, 30% requires sand blasting

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266 01	$3,266	Means 33-23-1180
TCLP VOC, SVOC, and Metal Analysis	12	EA	$1,065 35	$12,784	33-02-1705, Testing specifically for waste profiling
Excavation of Building Perimeter Soil					
Silt Fencing	7,000	EA	$3 90	$27,290	18 05 0206, Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	1,111	CY	$62 10	$68,995	17-02-0203, Break up pavement for excavation
966, 4 0 CY, Wheel Loader	123	HR	$151 47	$18,700	17-03-0224, Misc soil handling
Excavation, 1 Cy Hydraulic Excavator Med Mat'l 40 CY/HR	11,111	CY	$6 43	$71,499	17-03-0276
Bulk Solid Waste Loading into Truck	11,111	CY	$3.13	$34,741	33-19-0150, Load soil into dump truck
Air Monitoring Station	3	MO	$1,361.54	$3,774	33-01-0301, Perimeter air monitoring station west side
Confirmation Sampling After Soil Removal					
PID, per day	15	DAY	$179 53	$2,771	33-01-0303, Soil screening
Pesticides/PCBs Soil Analysis	282	EA	$269 30	$75,852	33-02-1717, Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	240	EA	$327 99	$78,719	33-02-1720; Confirmation Sampling
Polynuclear Aromatic Hydrocarbons, Soil Analysis	240	EA	$188 51	$45,241	33-02-1722, Confirmation Sampling
Transportation and Disposal					
Transport Bulk Solid Waste <50 ppm PCBs (Onsite)	750	MI	$2 58	$1,934	33-19-0205, Onsite trucking of <50 ppm material to berm area
Disposal in Berm Covered Below Under Backfill					
32 Ft Dump Truck Disposable Liner 6 Mil	93	EA	$53 17	$4,923	33-19-0807, Liners for every load >50 ppm
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	1,667	TON	$194 06	$323,431	EQ, >50 ppm trans & disposal
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts Spreading, Compaction	12,222	CY	$14 42	$176,248	17-03-0423, Bring in offsite material and backfill excavation
Fine Grading of Excavation	13,333	SY	$1 65	$22,013	17 03 0103 Grade material after placement
Hydroseed of Excavation Area	3	ACRE	$3,225	$8,884	CH2M HILL est
Backfill Berm with Excavated Material	11,111	CY	$6 61	$73,464	17-03-0415
Rough Grading (Berm)	16,667	SY	$5 98	$99,592	17-03-0101, Handle excavated material to rough grade
Backfill with Onsite Borrow, 6" Lifts, Spreading, Compaction	5,556	CY	$12.36	$68,803	17-03-0422, 1 foot thick cover material only
Backfill Excavation with Offsite Borrow, 6" Lifts Spreading, Compaction	10,624	CY	$14 42	$153,202	17-03-0423, Prepare additional area for extended berm, Assumes material can be placed on top of containment cells without damage
Fine Grading of Extended Area	56,944	SY	$1 65	$94,014	17 03 0103, Grade material after placement
Hydroseed of Berm Area	12	ACRE	$3,225	$37,943	CH2M HILL est
Building Decontamination					
Asbestos Survey	1	LS	$32,850 00	$32,850	ENTACT: Contaminated area only
Asbestos Removal - Pipe Insulation, air cell type, over 16" diameter	5,000	LF	$5 62	$28,123	25-01-0418, CH2M HILL Est
Asbestos Removal - Collect and bag bulk material, large product loader	3,927	EA	$5 56	$21,828	25-01-0502, 3 CF per bag
Asbestos - Double Bag and Decontaminate	3,927	EA	$35.38	$138,925	25-01-0503
Asbestos - Disposal charges, not including haul, average	145	CY	$187 43	$27,261	25-01-0506/7
Pressure Wash Decontamination Internal Surfaces	1	LS	$459,900 00	$459,900	ENTACT, Contaminated area only, 70% can be pressure washed (estimated)
Sand Blast Decontamination Internal Surfaces	1	LS	$394,200.00	$394,200	ENTACT, Only for material pressure wash decon will not work/painted material - Estimated at 30%
Clean Trenches, Sumps, and Pits	1	LS	$38,325 00	$38,325	Quote from ENTACT
Clean Equipment and Machinery in Building	1	LS	$43,800 00	$43,800	Quote from ENTACT
Decontaminated Storm Sewer South Side of Building	4,320	SF	$3 25	$14,041	33-17-0813 33-17-0815, 33-17-0817
Labor to Decontaminate Storm Sewer South Side of Building	43	HR	$86 40	$3,732	33-17-0823, 100 SF/Hour
Building Demolition					
Asset Recovery Value	1	LS	-$775,000 00	($775,000)	Quote from ENTACT, Assumes 62% of Assets in entire building is location in Contaminated Areas and all can be recovered
Steel Scrap Value	4,000	TON	-$120 00	($480,000)	Quote from ENTACT, Assumes 50% of steel in entire building is located in Contaminated Areas and all can be scrapped
Estimated Reduction in Steel Scrap Value by 2007	60	Percent		$288,000	Quote from ENTACT - Steel estimated to be reduced in scrap value by 60% by 2007
Demolition of Contaminated Areas	1	LS	$1,198,232 22	$1,198,232	Quote from ENTACT, Does not include T&D
Disposal of Construction and Demo Debris	17,196	TON	$49 55	$852,040	Quote from ENTACT, Brick, Office Materials, Unsold Items, Roofing, Assumed <50 ppm PCBs
Transportation and Disposal Demo Debris >50 ppm PCBs/Subtitle C	0	TON	$200 39	$0	Quote from ENTACT, Assume all C&D and cinder block is <50 ppm PCBs
Transportation and Disposal Demo Debris Consolidation Onsite	2,000	TON	$16 43	$32,850	Quote from ENTACT, All Material Other Than C&D Excluding Steel, Concrete, Asbestos (essentially cinder block)
Concrete Crusher for Onsite Reuse of Cinder Block	1	LS	$27,381 37	$27,381	Quote from ENTACT, Proportionate cost only for crushing and using onsite
Removal of Storm Sewer South Side of Building	1,375	LF	$17 98	$24,726	17-02-0301
Excavation for Removal	637	CY	$6 43	$4,096	17-03-0276
Removal of Catch Basins	9	EA	$45 03	$405	17-02-0305
Slab Demolition					
Demolition of Slab	1	LS	$499,695 59	$499,696	Quote from ENTACT - Does not include T&D
Concrete with acceptable levels for reuse	2,483	LOAD	$164 25	$407,833	Quote from ENTACT - T&D 10 tons per load
Concrete Crusher for Onsite Reuse	1	LS	$235,425 00	$235,425	Quote from ENTACT, Only for crushing and using onsite
Transportation and Disposal Concrete >50 ppm PCBs/Subtitle C	9,500	TON	$200 39	$1,903,658	Quote from ENTACT
Transportation and Disposal Concrete Consolidation Onsite	22,347	TON	$16 43	$367,049	Quote from ENTACT
Uncontaminated Building Area Demolition - NOT INCLUDED IN TOTAL COST					
Demolition of Slab	1	LS	$290,316 26	$290,316	Quote from ENTACT, Does not include T&D
Concrete with acceptable levels for reuse	2,216	LOAD	$164 25	$363,976	Quote from ENTACT - T&D 10 tons per load
Disposal of Construction and Demo Debris	9,227	TON	$49 55	$457,186	Quote from ENTACT, Brick, Office Materials, Unsold Items, Roofing, Assumed <50 ppm PCBs
Asset Recovery Value	1	LS	-$475,000 00	($475,000)	Quote from ENTACT, Assumes 38% of Assets in entire building is location in Uncontaminated Areas and all can be recovered
Steel Scrap Value	4,000	TON	-$120 00	($480,000)	Quote from ENTACT, Assumes 50% of steel in entire building is located in Uncontaminated Areas and all can be scrapped
Estimated Reduction in Steel Scrap Value by 2007	60	Percent		$288,000	Quote from ENTACT - Steel estimated to be reduced in scrap value by 60% by 2007
SUBTOTAL				$7,297,481	
Mobilization/Demobilization	5%			$364,873	Per CCI
Subcontractor General Conditions	15%			$1,094,619	Per CCI
SUBTOTAL				$8,756,954	
SUBTOTAL				$8,760,000	
Contingency	25%			$2,190,000	10% Scope + 15% Bid
SUBTOTAL				$10,950,000	
Project Management	5%			$547,500	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	6%			$657,000	USEPA 2000, p. 5-13, $2M-$10M. CH2M HILL est based on limited scope of design
Construction Management	10%			$1,095,000	USEPA 2000, p. 5-13, $2M-$10M; CH2M HILL est based on scope of construction
SUBTOTAL				$2,299,500	
TOTAL CAPITAL COST				**$13,250,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					*Year 1 to 50*
Cap Semi-annual Inspection	6	Hr	$80	$480	
Cap Repair	1 0	LS	$1,532	$1,532	Assumes 1% of cover cost to repair annually
Cap Inspection and Repair Report	1 0	LS	$5,000	$5,000	Biennial Report
SUBTOTAL				$7,012	
Contingency	30%			$2,104	10% Scope + 20% Bid
SUBTOTAL				$9,116	
Project Management	5%			$456	
Technical Support	10%			$912	
TOTAL ANNUAL O&M COST Year 1 to 50				**$10,500**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
			Total		$0	
TOTAL ANNUAL PERIODIC COST					**$0**	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$13,250,000	$13,250,000	1 000	$13,250,000	
ANNUAL O&M COST	1 to 50	$525,000	$10,500	25 730	$270,163	
PERIODIC COST	5	$0	$0	0 86	$0	
PERIODIC COST	10	$0	$0	0.74	$0	
PERIODIC COST	15	$0	$0	0.64	$0	
PERIODIC COST	20	$0	$0	0 55	$0	
PERIODIC COST	25	$0	$0	0.48	$0	
PERIODIC COST	30	$0	$0	0.41	$0	
PERIODIC COST	35	$0	$0	0.36	$0	
PERIODIC COST	40	$0	$0	0.31	$0	
PERIODIC COST	45	$0	$0	0.26	$0	
PERIODIC COST	50	$0	$0	0.23	$0	
		$13,800,000			$13,520,163	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$13,520,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000)

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Soil and Sediment Media- **Remediation to Residential PRGs**
Phase: Feasibility Study

Base Year: 2006
Date: 12/27/2006 13:25

	Alternative S1 No Further Action	**Alternative S2** Excavation and Offsite Disposal	**Alternative S3** Excavation, Offsite Disposal, and Onsite Consolidation	**Alternative S4** Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments
Total Project Duration (Years)	50	50	50	50
Capital Cost	$0	$7,580,000	$5,490,000	$5,940,000
Annual O&M Cost	$0	$0	$9,300	$9,300
Total Periodic Cost	$0	$0	$170,000	$170,000
Total Present Value of Alternative	$0	$7,580,000	$5,800,000	$6,250,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Alternative S1**
Name: **No Further Action**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: *Soil and Sediment Media- Remediation to Residential PRGs*
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:25

Description: No additional actions undertaken other than the required *5 year reviews.*

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Alternative					
No construction				$0	
TOTAL CAPITAL COST				$0	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$5,000	$0	
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
				Total	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1 000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$0	$0	0.71	$0	
PERIODIC COST	10	$0	$0	0.51	$0	
PERIODIC COST	15	$0	$0	0.36	$0	
PERIODIC COST	20	$0	$0	0.26	$0	
PERIODIC COST	25	$0	$0	0.18	$0	
PERIODIC COST	30	$0	$0	0.13	$0	
PERIODIC COST	35	$0	$0	0.09	$0	
PERIODIC COST	40	$0	$0	0.07	$0	
PERIODIC COST	45	$0	$0	0.05	$0	
PERIODIC COST	50	$0	$0	0 03	$0	
		$0			$0	
TOTAL PRESENT VALUE OF ALTERNATIVE					$0	

SOURCE INFORMATION

1. United States Environmental Protection Agency July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative S2**
Name: **Excavation and Offsite Disposal**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Soil and Sediment Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 25

Description: Soil samples for waste characterization
Soil excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone)
Cut off stream, pump around stream, sediment excavation and stabilization with lime
4% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil and sediment via dump to Subtitle D (<50 ppm PCBs) or Subtitle C (>50 ppm PCBs) landfill
Backfill of entire excavation to existing grade

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266 01	$3,266	Means 33-23-1180
TCLP VOC, SVOC, and Metal Analysis	8	EA	$1,065 35	$8,833	33-02-1705; Testing specifically for waste profiling
Excavation					
Silt Fencing	7,000	FT	$3 90	$27,290	18 05 0206; Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	10,073	CY	$37 63	$379,075	17-02-0201; Break up pavement for excavation
966, 4.0 CY, Wheel Loader	414	HR	$151 47	$62,718	17-03-0224; Misc soil handling
Excavation, 1 Cy Hydraulic Excavator, Med Mat'l, 40 CY/HR	37,265	CY	$6 43	$239,797	17-03-0276
Bulk Solid Waste Loading Into Truck	37,265	CY	$3 13	$116,516	33-19-0150; Load soil into dump truck
Air Monitoring Station	4	MO	$1,361 54	$5,072	33-01-0301; Perimeter air monitoring station west side
Sediment - Install and Remove Sheet Piling Cutoff Wall 2 North, 2 South	3,600	SF	$15 48	$55,732	17-03-0902; 30 feet x 30 feet sheet piling across stream in 2 places each stream
Sediment - Operate Pump Around System 1 North, 1 South	10	DAY	$131.40	$1,314	17-03-1004; 2 pumps systems - 1 for each stream, 5 days at production rate
Sediment Double Handle - Excavation - Bank to Stabilization Area	4,200	CY	$6 43	$27,027	17-03-0276, Move soil from stream bank to stabilization area; initial excavation and loading covered above
Reduce Moisture Content of Sediment Via Stabilization/Lime 5%	210	CY	$327 88	$68,855	17-03-0601
Confirmation Sampling					
PID, per day	52	DAY	$179 53	$9,292	33-01-0303; Soil screening
Pesticides/PCBs Soil Analysis	969	EA	$269 30	$260,905	33-02-1717, Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	0	EA	$327 99	$0	33-02-1720; Confirmation Sampling
Polynuclear Aromatic Hydrocarbons Soil Analysis	829	EA	$188 51	$156,290	33-02-1722; Confirmation Sampling
Transportation and Disposal					
Transport <50 ppm PCBs, Dump Truck, 20 T	53,661	TON	$7 60	$408,050	Onyx; <50 ppm material transportation to landfill
32 Ft. Dump Truck Disposable Liner, 6 Mil	3,105	EA	$53 17	$165,122	33-19-0807; Liners for every load
Landfill <50 ppm PCBs Disposal/Subtitle D	53,661	TON	$20 74	$1,113,160	Onyx; <50 ppm material disposal at landfill
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	2,236	TON	$194 06	$433,893	EQ; >50 ppm trans & disposal
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	40,991	CY	$14.42	$591,106	17-03-0423; Bring in offsite material and backfill excavation
Fine Grading	60,440	SY	$1 65	$99,786	17 03 0103; Grade material after placement.
Hydroseed of Excavation Area	12	ACRE	$3,225	$40,273	CH2M HILL est.
SUBTOTAL				$4,273,369	
Mobilization/Demobilization	5%			$213,668	Per CCI
Subcontractor General Conditions	15%			$606,955	Per CCI
SUBTOTAL				$5,095,993	
SUBTOTAL				$5,095,993	
Contingency	25%			$1,273,998	*10% Scope + 15% Bid*
SUBTOTAL				$6,369,991	
Project Management	**5%**			$318,500	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	**4%**			$254,800	**USEPA 2000, p. 5-13, $2M-$10M**; CH2M HILL est based on limited scope of design
Construction Management	**10%**			$636,999	**USEPA 2000, p. 5-13, $2M-$10M**; CH2M HILL est based on scope of construction
SUBTOTAL				$1,210,298	
TOTAL CAPITAL COST				***$7,580,000***	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	Hr	$60	$0	
Contingency	30%			$0	10% Scope + 20% Bid
SUBTOTAL				$0	
Project Management	5%			$0	
Technical Support	10%			$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS		$0	
5 year Review	10	1	LS		$0	
5 year Review	15	1	LS		$0	
5 year Review	20	1	LS		$0	
5 year Review	25	1	LS		$0	
5 year Review	30	1	LS		$0	
5 year Review	35	1	LS		$0	
5 year Review	40	1	LS		$0	
5 year Review	40	1	LS		$0	
5 year Review	45	1	LS		$0	
5 year Review	50	1	LS		$0	
				Total	$0	
TOTAL ANNUAL PERIODIC COST					**$0**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$7,580,000	$7,580,000	1.000	$7,580,000	
ANNUAL O&M COST	1 to 50	$0	$0	25.730	$0	
PERIODIC COST	5	$0	$0	0.86	$0	
PERIODIC COST	10	$0	$0	0.74	$0	
PERIODIC COST	15	$0	$0	0.64	$0	
PERIODIC COST	20	$0	$0	0 55	$0	
PERIODIC COST	25	$0	$0	0.48	$0	
PERIODIC COST	30	$0	$0	0.41	$0	
PERIODIC COST	35	$0	$0	0.36	$0	
PERIODIC COST	40	$0	$0	0.31	$0	
PERIODIC COST	45	$0	$0	0 26	$0	
PERIODIC COST	50	$0	$0	0 23	$0	
		$7,600,000			$7,580,000	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$7,580,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000).

Alternative: **Alternative S3** — **COST ESTIMATE SUMMARY**

Name: **Excavation, Offsite Disposal, and Onsite Consolidation**

Site: OMC Plant 2 Superfund Site, Waukegan, IL
Location: Soil and Sediment Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 25

Description: Soil samples for waste characterization
Soil and sediment excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone)
Cut off stream, pump around stream, sediment excavation and stabilization with lime
4% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil/sediment via truck to onsite berm location for <50 ppm PCBs.
Transportation/Disposal of soil/sediment via truck to Subtitle C (>50 ppm PCBs) landfill.
Backfill of entire excavation to existing grade
Handling, compaction of berm material including 1 foot thick cover (general fill)
Long term O&M/Inspections for Berm

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$16,425	$16,425	Source 1
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266.01	$3,266	Means 33-23-1180
TCLP VOC, SVOC, and Metal Analysis	8	EA	$1,065 35	$8,833	33-02-1705; Testing specifically for waste profiling
Excavation					
Silt Fencing	7,000	FT	$3 90	$27,290	18 05 0206; Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	10,073	CY	$37 63	$379,075	17-02-0201, Break up pavement for excavation
966, 4 0 CY, Wheel Loader	414	HR	$151 47	$62,718	17-03-0224; *Misc. soil handling*
Excavation, 1 Cy Hydraulic Excavator, Med Mat'l, 40 CY/HR	37,265	CY	$6 43	$239,797	17-03-0276
Bulk Solid Waste Loading Into Truck	37,265	CY	$3.13	$116,516	33-19-0150, Load soil into dump truck
Air Monitoring Station	4	MO	$1,361 54	$5,072	33-01-0301, Perimeter air monitoring station west side
Sediment - Install and Remove Sheet Piling Cutoff Wall 2 North, 2 South	3,600	SF	$15 48	$55,732	17-03-0902; 30 feet x 30 feet sheet piling across stream in 2 places each stream
Sediment - Operate Pump Around System 1 North, 1 South	10	DAY	$131 40	$1,314	17-03-1004; 2 pumps systems - 1 for each stream, 5 days at production rate
Sediment Double Handle - Excavation - Bank to Stabilization Area	4,200	CY	*$6 43*	$27,027	17-03-0276; Move soil from stream bank to stabilization area, *initial excavation and loading covered above*
Reduce Moisture Content of Sediment Via Stabilization/Lime 5%	210	CY	$327 88	$68,855	17-03-0601
Confirmation Sampling					
PID, per day	52	DAY	$179 53	$9,292	33-01-0303, Soil screening
Pesticides/PCBs Soil Analysis	835	EA	$269 30	$224,778	33-02-1717, Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	0	EA	$327 99	$0	33-02-1720, Confirmation Sampling
Polynuclear Aromatic Hydrocarbons, Soil Analysis	829	EA	$188 51	$156,290	33-02-1722, Confirmation Sampling
Transportation and Disposal					
Transport Bulk Solid Waste <50 ppm PCBs (Onsite)	2,683	MI	$2 58	$6,917	33-19-0205; Onsite trucking of <50 ppm material to berm area
Disposal in Berm Covered Below Under Backfill					
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	2,236	TON	$194.06	$433,893	EQ; >50 ppm trans & disposal
32 Ft Dump Truck Disposable Liner, 6 Mil	124	EA	$53 17	$6,605	33-19-0807; Liners for every load
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	40,991	CY	$14 42	$591,106	17-03-0423; Bring in offsite material and backfill excavation
Fine Grading of Excavation	60,440	SY	$1 65	$99,786	17 03 0103; Grade material after placement
Hydroseed of Excavation Area	12	ACRE	$3,225	$40,273	CH2M HILL est.
Backfill Berm with Excavated Material	35,774	CY	$6 61	$236,532	17-03-0415
Rough Grading (Berm)	16,667	SY	$5 98	$99,592	17-03-0101, Handle excavated material to rough grade
Backfill with Onsite Borrow, 6" Lifts, Spreading, Compaction	5,556	CY	$12 38	$68,803	17-03-0422; 1 foot thick cover material only
Hydroseed of Berm Area	12	ACRE	$3,225	$37,943	CH2M HILL est.
SUBTOTAL				$3,023,729	
Mobilization/Demobilization	5%			$151,186	Per CCI
Subcontractor General Conditions	15%			$453,559	Per CCI
SUBTOTAL				$3,628,474	
SUBTOTAL				$3,628,474	
Contingency	25%			$907,119	10% Scope + 15% Bid
SUBTOTAL				$4,535,593	
Project Management	5%			$226,780	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	6%			$272,136	**USEPA 2000, p. 5-13, $2M-$10M**, *CH2M HILL est based on limited scope of design*
Construction Management	10%			$453,559	**USEPA 2000, p. 5-13, $2M-$10M**; CH2M HILL est based on scope of construction
SUBTOTAL				$952,474	
TOTAL CAPITAL COST				**$5,490,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Berm O&M					Year 1 to 50
Berm Semi-annual Inspection	8	Hr	$60	$480	
Berm Repair	1.0	LS	$753	$753	Assumes 1% of cover cost to repair annually
Berm Inspection and Repair Report	1.0	LS	$5,000	$5,000	Annual report
SUBTOTAL				$6,233	
Contingency	30%			$1,870	10% Scope + 20% Bid
SUBTOTAL				$8,103	
Project Management	5%			$405	
Technical Support	10%			$810	
SUBTOTAL Year 1 to 50				**$9,300**	
TOTAL ANNUAL O&M COST Year 0 to 50				**$9,300**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$170,000	
TOTAL ANNUAL PERIODIC COST					**$170,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$5,490,000	$5,490,000	1.000	$5,490,000	
ANNUAL O&M COST - Berm	1 to 50	$465,000	$9,300	25.7	$239,287	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$6,100,000			$5,801,982	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$5,800,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative S4**
Name: **Excavation, Offsite Disposal, and Onsite Consolidation with Harbor Sediments**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 Superfund Site Waukegan, IL
Location: Soil and Sediment Media- Remediation to Residential PRGs
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 25

Description:
Soil samples for waste characterization
Soil and sediment excavation of PCBs/SVOCs from 0-5 feet (unsaturated zone)
Cut off stream, pump around stream, sediment excavation and stabilization with lime
4% of excavated soil is above 50 ppm PCBs
Transportation/Disposal of soil/sediment via dump to onsite berm location for Subtitle D (<50 ppm PCBs)
Transportation/Disposal of soil/sediment via dump to Subtitle C (>50 ppm PCBs)
Backfill of entire excavation to existing grade
Handling, compaction of berm material including 1 foot thick cover (general fill)
Long term O&M/Inspections for Berm
Material can be placed on top of containment cells without damaging containment cells

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$16,425	$16,425	Source 1
Soil Waste Characterization					
Mob/demob, Drill Equipment or Trencher, Crew	1	EA	$3,266.01	$3,266	Means 33-23-1160
TCLP VOC, SVOC, and Metal Analysis	8	EA	$1,065.35	$8,633	33-02-1705; Testing specifically for waste profiling
Excavation					
Silt Fencing	7,000	0	$3.90	$27,290	18 05 0206; Erosion control around site perimeter
Demolish Bituminous Pavement with Air Equipment	10,073	CY	$37.63	$379,075	17-02-0201; Break up pavement for excavation
966, 4 0 CY, Wheel Loader	414	HR	$151.47	$62,718	17-03-0224; Misc. soil handling
Excavation, 1 Cy Hydraulic Excavator, Med Mat'l, 40 CY/HR	37,265	CY	$6.43	$239,797	17-03-0276
Bulk Solid Waste Loading Into Truck	37,265	CY	$3.13	$116,516	33-19-0150, Load soil into dump truck
Air Monitoring Station	4	MO	$1,361.54	$5,072	33-01-0301; Perimeter air monitoring station west side
Sediment - Install and Remove Sheet Piling Cutoff Wall 2 North, 2 South	3,600	SF	$15 46	$55,732	17-03-0902, 30 feet x 30 feet sheet piling across stream in 2 places each stream
Sediment - Operate Pump Around System 1 North, 1 South	10	DAY	$131 40	$1,314	17-03-1004; 2 pumps systems - 1 for each stream; 5 days at production rate
Sediment Double Handle - Excavation - Bank to Stabilization Area	4,200	CY	$6.43	$27,027	17-03-0276; Move soil from stream bank to stabilization area, initial excavation and loading covered above
Reduce Moisture Content of Sediment Via Stabilization/Lime 5%	210	CY	$327 88	$68,855	17-03-0601
Confirmation Sampling					
PID, per day	52	DAY	$179 53	$9,292	33-01-0303; Soil screening
Pesticides/PCBs Soil Analysis	835	EA	$269 30	$224,778	33-02-1717; Confirmation sampling plus disposal screening
Volatile Organic Analysis, Soils	0	EA	$327.99	$0	33-02-1720; Confirmation Sampling
Polynuclear Aromatic Hydrocarbons, Soil Analysis	829	EA	$188.51	$156,290	33-02-1722; Confirmation Sampling
Transportation and Disposal					
Transport Bulk Solid Waste <50 ppm PCBs (Onsite)	2,683	MI	$2.58	$6,917	33-19-0205; Onsite trucking of <50 ppm material to berm area
Disposal in Berm Covered Below Under Backfill					
Transportation and Landfill >50 ppm PCBs Disposal/Subtitle C	2,236	TON	$194.06	$433,893	EQ; >50 ppm trans & disposal
32 Ft. Dump Truck Disposable Liner, 6 Mil	124	EA	$53.17	$6,605	33-19-0807; Liners for every load
Backfill					
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	40,991	CY	$14.42	$591,106	17-03-0423; Bring in offsite material and backfill excavation
Fine Grading of Excavation	60,440	SY	$1.65	$99,786	17 03 0103, Grade material after placement
Hydroseed of Excavation Area	12	ACRE	$3,225	$40,273	CH2M HILL est.
Backfill Berm with Excavated Material	35,774	CY	$6.61	$236,532	17-03-0415
Rough Grading (Berm)	16,667	SY	$5.98	$99,592	17-03-0101; Handle excavated material to rough grade
Backfill with Onsite Borrow, 6" Lifts, Spreading, Compaction	5,556	CY	$12.38	$68,803	17-03-0422; 1 foot thick cover material only
Backfill Excavation with Offsite Borrow, 6" Lifts, Spreading, Compaction	10,624	CY	$14.42	$153,202	17-03-0423, Prepare additional area for extended berm; Assumes material can be placed on top of containment cells without damage
Fine Grading of Extended Area	56,944	SY	$1.65	$94,014	17 03 0103; Grade material after placement
Hydroseed of Berm Area	12	ACRE	$3,225	$37,943	CH2M HILL est.
SUBTOTAL				$3,270,945	
Mobilization/Demobilization	5%			$163,547	Per CCI
Subcontractor General Conditions	15%			$490,642	Per CCI
SUBTOTAL				$3,925,134	
SUBTOTAL				$3,925,134	
Contingency	25%			$981,284	10% Scope + 15% Bid
SUBTOTAL				$4,906,418	
Project Management	5%			$245,321	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	6%			$294,385	USEPA 2000, p. 5-13, $2M-$10M; CH2M HILL est based on limited scope of design
Construction Management	10%			$490,642	USEPA 2000, p. 5-13, $2M-$10M; CH2M HILL est based on scope of construction
SUBTOTAL				$1,030,348	
TOTAL CAPITAL COST				$5,940,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Berm O&M					Year 1 to 50
Berm Semi-annual Inspection	8	Hr	$60	$480	
Berm Repair	1 0	LS	$753	$753	Assumes 1% of cover cost to repair annually
Berm Inspection and Repair Report	1.0	LS	$5,000	$5,000	Annual report
SUBTOTAL				$6,233	
Contingency	30%			$1,870	10% Scope + 20% Bid
SUBTOTAL				$8,103	
Project Management	5%			$405	
Technical Support	10%			$810	
SUBTOTAL Year 1 to 50				$9,300	
TOTAL ANNUAL O&M COST Year 0 to 50				$9,300	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
			Total		$170,000	
TOTAL ANNUAL PERIODIC COST					$170,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$5,940,000	$5,940,000	1.000	$5,940,000	
ANNUAL O&M COST	1 to 50	$465,000	$9,300	25.730	$239,287	
PERIODIC COST	5	$15,000	$15,000	0 86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0 36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0 23	$3,422	
		$6,600,000			$6,251,982	
TOTAL PRESENT VALUE OF ALTERNATIVE					$6,250,000	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000).

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: DNAPL
Phase: Feasibility Study

Base Year: 2006
Date: 12/27/2006 14:08

	Alternative D1	Alternative D2	Alternative D3	Alternative D4	Alternative D5
	No Further Action	MNA and Institutional Controls	Extraction, Onsite Collection, and Offsite Destruction	In-Situ Thermal Treatment	In-Situ Soil Mixing
Total Project Duration (Years)	50	50	50	10	10
Capital Cost	$0	$15,000	$154,240	$4,500,000	$561,400
Annual O&M Cost	$0	$19,000	$19,094	$995,000	$19,200
Total Periodic Cost	$150,000	$150,000	$150,000	$30,000	$30,000
Total Present Value of Alternative	$73,000	$690,000	$977,600	$6,554,000	$749,300

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Alternative D1** **COST ESTIMATE SUMMARY**
Name: **No Further Action**

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: DNAPL
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:17

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$0	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	25.73	$0	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$150,000			$72,695	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$73,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative D2**
Name: **MNA and Institutional Controls**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: DNAPL
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:17

Description: Institutional controls include identification of DNAPL area. Confirmation groundwater sampling would be conducted every quarter for 2 years and then annually thereafter to assure that attenuation is occuring and that the plume is not expanding.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	ID DNAPL Area
TOTAL CAPITAL COST				**$15,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater MNA Samples		8	EA	$360	$2,880	Contractor Estimate
QC Samples		1	EA	$360	$360	Contractor Estimate
Groundwater Sampling, Level D						
Labor		80	HRS	$80	$6,400	CH2M Est. - 3 persons
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$12,240	
Allowance for Misc. Items		20%			$2,448	
SUBTOTAL					$14,688	
Contingency		30%			$4,406	10% Scope + 20% Bid
SUBTOTAL					$19,094	
TOTAL ANNUAL O&M COST Year 0 to 2					**$76,378**	Quarterly
TOTAL ANNUAL O&M COST Year 3 to 50					**$19,094**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$15,000	$15,000	1.000	$15,000	
ANNUAL O&M COST - Quarterly Sampling	1 to 3	$229,133	$76,378	2.829	$216,043	
ANNUAL O&M COST - Annual Sampling	4 to 50	$897,437	$19,094	22.901	$383,273	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$1,291,570			$687,010	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$690,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: Alternative D3 — **COST ESTIMATE SUMMARY**

Name: Extraction, Onsite Collection, and Offsite Destruction

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: DNAPL
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 17

Description: Mobile DNAPL would be pumped out of the subsurface using 1 extraction well and pump DNAPL would be collected onsite for shipment to an offsite hazardous waste treatment facility

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	Identify DNAPL Area
Extraction Well Installation					
Mobilization/Demobilization	1	LS	$5,000	$5,000	Includes submittals.
Hollow-Stem Auger Drilling (8 25" ID)	30	LF	$95	$2,850	Aquadrill, Inc Quote
6-inch Carbon Steel Well Casing	25	LF	$37	$925	IPS Drilling
6-inch Stainless Steel Well Screen	5	LF	$89	$445	IPS Drilling
Well Construction Materials	30	FT	$30	$900	Aquadrill, Inc Quote
Well Vault and Installation	1	EA	$1,000	$1,000	CH2M HILL Est
Surveying	1	EA	$250	$250	Project Exper
IDW Disposal	1	LS	$1,500	$1,500	Project Exper
Oversight Labor	24	HR	$80	$1,920	CH2M HILL 1 person
Drilling Crew Per Diem	3	DY	$250	$750	Project Exper
SUBTOTAL				$15,540	
Monitoring Well Installation					
Mobilization/Demobilization	1	LS	$5,000	$5,000	Includes submittals.
Hollow-Stem Auger Drilling (4 25" ID)	180	FT	$25	$4,482	Project Exper
2-inch PVC Well Casing	140	FT	$2 90	$406	33-23-0101
2-inch Stainless Steel Well Screen	40	FT	$40 00	$1,600	IPS Drilling
Well Construction Materials	180	FT	$30	$5,400	Project Exper
Well Covers	8	EA	$90	$720	Century Products, Inc
Well Development	8	EA	$250	$2,000	Project Exper
IDW Disposal	1	LS	$750	$750	Project Exper
Drilling Crew Per Diem	5	DY	$250	$1,250	Project Exper
Oversight Labor	60	HR	$80	$4,800	CH2M HILL 1 person
Oversight Per Diem	5	DY	$250	$1,250	CH2M HILL 1 person
SUBTOTAL				$27,658	
Extraction Pump & Containment System					
2-inch Electric DNAPL Extraction Pump	1	EA	$1,950 00	$1,950	Xitech, Inc
Solar Power Control System	1	EA	$4,550	$4,550	Xitech, Inc
40-watt Solar Panel	1	EA	$630	$630	Xitech, Inc
Wiring	200	FT	$2	$400	Xitech, Inc
Discharge Tubing	200	FT	$1	$200	Xitech, Inc
Trenching	200	FT	$30	$6,000	Project Exper
Level Switch	1	EA	$650	$650	Xitech, Inc
Installation & Testing Labor	100	HR	$80	$8,000	CH2M HILL 2 people
SUBTOTAL				$22,380	
Outdoor Storage Area					
Fencing Installation	1	LS	$3,500	$3,500	Project Exper
Refurbish Gas Cylinder Storage Area	1	LS	$5,000	$5,000	Project Exper
Signage	1	LS	$500	$500	Project Exper
SUBTOTAL				$9,000	
RCRA Small Quantity Generator Permit					
Permit Application	40	HR	$80	$3,200	CH2M HILL 1 person
SUBTOTAL				$92,778	
Contingency	25%			$23,195	10% Scope + 15% Bid
SUBTOTAL				$115,973	
Project Management	8%			$9,278	USEPA 2000, p 5-13, $2M-$10M
Remedial Design	15%			$17,396	USEPA 2000, p 5-13, $2M-$10M
Construction Management	10%			$11,597	USEPA 2000, p 5-13, $2M-$10M
SUBTOTAL				$38,271	
TOTAL CAPITAL COST				$154,240	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater MNA Samples		8	EA	$360	$2,880	Contractor Estimate
QC Samples		1	EA	$360	$360	Contractor Estimate
Groundwater Sampling, Level D						
Labor		80	HRS	$80	$6,400	CH2M Est - 3 persons
Equipment - meters		1	LS	$500	$500	CH2M Est
Consumables		1	LS	$500	$500	CH2M Est
Data Validation		4	HRS	$80	$320	CH2M Est
Reporting		16	HRS	$80	$1,280	CH2M Est
SUBTOTAL					$12,240	
Allowance for Misc Items		20%			$2,448	
SUBTOTAL					$14,688	
Contingency		30%			$4,406	10% Scope + 20% Bid
SUBTOTAL					$19,094	
Total Annual GW Monitoring Year 0 to 3					$76,378	Quarterly
Total Annual GW Monitoring Year 4 to 50					$19,094	
DNAPL Disposal Year 0 to 5						
Characterization Sampling		1	LS	$750	$750	Project Exper
Oversight of DNAPL Loading		40	HR	$80	$3,200	CH2M HILL 1 person
Annual DNAPL Disposal		6	DRUM	$1,000.00	$6,000	CH2M HILL Estimate
SUBTOTAL					$9,950	
System O&M						
Pump Maintenance		40	HR	$80	$3,200	Project Exper
Building Maintenance		40	HR	$80	$3,200	CH2M HILL 1 person
SUBTOTAL					$6,400	
DNAPL Subtotal					$16,350	
Contingency		30%			$4,905	10% Scope + 20% Bid
SUBTOTAL					$21,255	
Total Annual O & M Year 0 to 3					$97,633	
Total Annual O & M Year 4 to 5					$40,349	
Total Annual O & M Year 6 to 50					$19,094	System Operation for 5 years

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
TOTAL ANNUAL PERIODIC COST					$150,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$154,240	$154,240	1 000	$154,240	
ANNUAL O&M COST	1 - 3	$292,898	$97,633	2.83	$276,165	
ANNUAL O&M COST	4 - 5	$80,699	$40,349	1 75	$70,656	
ANNUAL O&M COST	6 - 50	$859,248	$19,094	21 15	$403,848	
PERIODIC COST	5	$15,000	$15,000	0 86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0 41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0 36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0 26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0 23	$3,422	
		$1,537,085			$977,603	
TOTAL PRESENT VALUE OF ALTERNATIVE					$977,600	

SOURCE INFORMATION

1 United States Environmental Protection Agency July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000)

Alternative: **Alternative D4** **COST ESTIMATE SUMMARY**

Name: **In-Situ Thermal Treatment**

Site:	OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL	**Description:**	Treatment of DNAPL using thermal wells and heated extraction wells and soil-vapor extraction wells to extract volatilized contaminants. Treatment of extracted contaminants with vapor & liquid treatment system
Media:	DNAPL		
Phase:	Feasibility Study		
Base Year:	2006		
Date:	5/30/2006 13 55		

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
ISTD System Installation					
Mobilization & Site Prep	1	LS	$285,000	$285,000	Includes submittals.
Drilling Mobilization	1	LS	$5,000	$5,000	CH2M HILL Est.
Hollow-Stem Auger Drilling (6 25" ID)	750	FT	$64	$47,700	IPS Drilling Quote
4-inch Carbon Steel Well Casing	125	FT	$18	$2,250	Century Products, Inc.
4-inch Stainless Steel Well Screen	625	FT	$45	$28,125	Century Products, Inc
Well Vaults	25	EA	$1,000	$25,000	CH2M HILL Est.
Well Development	25	EA	$250	$6,250	IPS Drilling Quote
Well Construction Materials	750	FT	$30	$22,500	IPS Drilling Quote
Drilling Crew Per Diem	25	DY	$250	$6,250	IPS Drilling Quote
Oversight Per Diem	25	DY	$750	$18,750	CH2M HILL Est. - 3 people
Well Decommissioning	25	EA	$500	$12,500	Contractor Estimate
Demobilization	1	LS	$75,000	$75,000	Contractor Estimate
Electrical Installation	1	LS	$341,700	$341,700	CH2M HILL Estimate
Electrical Connection	1	LS	$350,000	$350,000	CH2M HILL Estimate
Well Field Piping	2,500	FT	$6.39	$15,975	CH2M HILL Estimate
Shakedown Testing	1	LS	$150,000	$150,000	Contractor Estimate
SUBTOTAL				$1,392,000	
Offgas Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$60,000	$60,000	CH2M HILL Est
5,000 Gallon Tank	1	EA	$7,954	$7,954	RS Means 33-10- 9660
MCC	1	EA	$40,000	$40,000	CH2M HILL Est.
GAC Treatment System	1	EA	$44,000	$44,000	Contractor Quotation
INC (transducers, etc)	30	EA	$2,150	$64,500	Supplier Quotation
Transfer Pump	4	EA	$6,500	$26,000	CH2M HILL Est
PLC w/ Autodialer	1	LS	$35,000	$35,000	CH2M HILL Est.
System Programming	150	HR	$100	$15,000	CH2M HILL Est
Fittings, Valves, Miscellaneous Appertanances	1	LS	$20,000	$20,000	CH2M HILL Est
Discharge Flowmeter	1	EA	$12,000	$12,000	CH2M HILL Est.
Discharge Pipe	1,000	FT	$6 39	$6,390	Supplier Quotation
Mechanical Installation	25	PERCENT	$1,042,327	$260,582	CH2M HILL Est
Electrical Installation	35	PERCENT	$1,042,327	$364,814	CH2M HILL Est
Heat Tracing	2,500	FT	$10	$25,000	CH2M HILL Est
Bag Filters	4	EA	$250	$1,000	CH2M HILL Est
Rotating Vacuum Drum Filter	1	EA	$100,000	$100,000	Supplier Quotation
pH Adjustment Storage Tanks	2	EA	$7,954	$15,908	RS Means 33-10-9660
Mixer	3	EA	$4,362	$13,087	RS Means 33-13-0428
Mixing Tank	3	EA	$4,714	$14,141	RS Means 33-10-9658
Chemical Feeder	3	EA	$3,099	$9,297	RS Means 33-12-9905
Startup - Labor	160	HRS	$80	$12,800	CH2M Est - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est
DAF System	1	EA	$123,000	$123,000	Supplier Quotation
Polymer Feed System	1	EA	$23,000	$23,000	Supplier Quotation
Dosing Pump	2	EA	$5,000	$10,000	Supplier Quotation
Air Compressor	1	EA	$5,000	$5,000	Supplier Quotation
SUBTOTAL				$1,311,473	
SUBTOTAL				$2,718,473	
Contingency	25%			$679,618	10% Scope + 15% Bid
SUBTOTAL				$3,398,092	
Project Management	6%			$203,885	USEPA 2000, p 5-13, $500K-$2M
Remedial Design	15%			$509,714	USEPA 2000, p 5-13, $500K-$2M
Construction Management	10%			$339,809	USEPA 2000, p 5-13, $500K-$2M
SUBTOTAL				$1,053,408	
TOTAL CAPITAL COST				**$4,500,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater MNA Samples		8	LS	$360	$2,880	
QC Samples		1	LS	$360	$360	
Groundwater Sampling, Level D						
Labor		80	HRS	$80	$6,400	CH2M Est
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est
SUBTOTAL					$12,240	
Allowance for Misc. Items		20%			$2,448	
SUBTOTAL					$14,688	
Contingency		30%			$4,406	10% Scope + 20% Bid
SUBTOTAL					$19,094	
Treatment System						
Routine Operations, Maintenance, Monitoring		625	HR	$80	$50,000	
Waste Transport		11	EA	$115	$1,256	Assumes 20 tons/load non-hazardous
Waste Disposal		218	TON	$18	$3,931	Assumes non-hazardous
pH Adjustment - Acid		18,250	GAL	$1	$18,250	Assumes 98% sulfuric acid
pH Adjustment - Base		23,725	GAL	$2	$47,450	Assumes 20% NaOH
Monthly Influent/Effluent Sampling Labor		50	HR	$80	$4,000	1 Site Visit Per Month
Monthly Influent/Effluent Sampling Analytical		12	EA	$285	$3,420	VOC analysis
Data Validation, Database Management		31	HR	$80	$2,480	
O&M Project Management		1	LS	$19,618	$19,618	
Electricity		12	Months	$200	$2,400	
Reporting		1	LS	$20,000	$20,000	
Groundwater Discharge		12	LS	$0.00	$0	Assumes NPDES Discharge
Electricity For ISTD System Operation		3,000,000	KWH	$0.08	$233,100	MEANS 33-42-0101
ISTD System O&M		2	YR	$165,000.00	$330,000	
SUBTOTAL					$735,905	
Contingency		30%			$220,772	10% Scope + 20% Bid
SUBTOTAL					$975,771	
TOTAL ANNUAL O&M COST					**$995,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
SUBTOTAL					$30,000	
TOTAL ANNUAL PERIODIC COST					**$30,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$4,500,000	$4,500,000	1.000	$4,500,000	
ANNUAL O&M COST (system operation)	1 to 2	$1,990,000	$995,000	1.91	$1,903,902	
ANNUAL O&M COST (MNA only)	3 to 10	$152,755	$19,094	6.62	$126,343	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
		$6,672,755			$6,554,345	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,554,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000 *A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study*. EPA 540-R-00-002. (USEPA, 2000).

Alternative:	**Alternative D5**		**COST ESTIMATE SUMMARY**
Name:	**In-Situ Soil Mixing**		

Site:	OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL	**Description:**	Soils would be mixed with bentonite clay and zero-valent iron using large diameter augers to stabilize and treat DNAPL area approximately 5,600 square feet with a DNAPL thickness of 2 feet.
Media:	DNAPL		
Phase:	Feasibility Study		
Base Year:	2006		
Date:	12/27/2006 13:17		

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
Soil Mixing					
Mobilization/Demobilization	1	LS	$50,000	$50,000	Includes submittals;
Soil Mixing	1	LS	$130,000	$130,000	Geo-Solutions Quotation
ZVI-Clay Amendment	34	TN	$750	$25,500	Project Exper
Installation of Potable Water Line	1	LS	$50,000	$50,000	CH2M HILL Est.
Access Restriction (Fencing)	1	LS	$3,500	$3,500	CH2M HILL Est.
Oversight Labor	150	HR	$80	$12,000	CH2 HILL 1 person
Oversight Per Diem	15	DY	$250	$3,750	CH2M HILL 1 person
SUBTOTAL				$274,750	
Soil Confirmation Sampling					
Soil Confirmation Samples During Mixing	20	EA	$150	$3,000	CH2M HILL Est.
Soil Confirmation Samples Post-Mixing	20	EA	$150	$3,000	Project. Experience
Direct Push Contractor	1	EA	$2,500	$2,500	IPS Drilling Quotation
Contractor Per Diem	2	DY	$250	$500	IPS Drilling Quotation
Oversight Labor	24	HRS	$80	$1,920	CH2M HILL 1 Person
Oversight Per Diem	2	DY	$250	$500	CH2M HILL 1 Person
SUBTOTAL				$11,420	
Groundwater Monitoring Network Expansion					
Mobilization/Demobilization	1	LS	$5,000	$5,000	IPS Drilling Quotation
Hollow-Stem Auger Drilling (4.25" ID Augers)	180	FT	$25	$4,482	IPS Drilling Quotation
2-inch PVC Well Casing	140	FT	$2.90	$406	Century Products, Inc.
2-inch Stainless Steel Well Screen	40	FT	$40	$1,600	IPS Drilling
Well Construction Materials	180	FT	$30	$5,400	IPS Drilling Quotation
Well Covers	8	EA	$90	$720	Century Products, Inc.
Well Development	8	EA	$250	$2,000	IPS Drilling Quotation
2" Expanding Locking Cap	8	EA	$22	$176	Century Products, Inc.
Drilling Contractor Per Diem	10	DY	$250	$2,500	IPS Drilling Quotation
Oversight Labor	100	HR	$80	$8,000	CH2M HILL 1 Person
Oversight Per Diem	100	DY	$250	$25,000	CH2M HILL 1 Person
SUBTOTAL				$55,284	
SUBTOTAL				$356,454	
Contingency	25%			$89,114	10% Scope + 15% Bid
SUBTOTAL				$445,568	
Project Management	6%			$26,734	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$53,468	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$35,645	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$115,848	
TOTAL CAPITAL COST				**$561,400**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Annual GW Sampling						
Groundwater Samples		8	LS	$360	$2,880	
QC Samples		1	LS	$360	$432	
Groundwater Sampling, Level D						
Labor		80	HRS	$80	$6,400	CH2M HILL 2 persons
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$12,312	
Allowance for Misc. Items		20%			$2,462	
SUBTOTAL					$14,774	
Contingency		30%			$4,432	10% Scope + 20% Bid
SUBTOTAL					$19,207	
TOTAL ANNUAL O&M COST					**$19,200**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
SUBTOTAL					$30,000	
TOTAL ANNUAL PERIODIC COST					**$30,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$561,400	$561,400	1.000	$561,400	
ANNUAL O&M COST	1 to 10	$192,000	$19,200	8.53	$163,780	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
		$783,400			$749,280	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$749,300**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study

Base Year: 2006
Date: 12/27/2006 13:21

	Alternative G1	Alternative G2	Alternative G3a	Alternative G3b	Alternative G4a	Alternative G4b	Alternative G5
	No Further Action.	MNA and Institutional Controls.	In-Situ Chemical Reduction	Enhanced In-Situ Bioremediation	Groundwater Collection and Treatment with Monitored Natural Attenuation	Groundwater Collection and Treatment to MCLs	In-Situ Thermal Treatment
Total Project Duration (Years)	50	50	50	50	50	50	10
Capital Cost	$0	$15,000	$7,026,200	$4,998,600	$2,500,000	$3,582,900	$13,600,000
Annual O&M Cost	$0	$96,000	$95,000	$95,000	$424,000	$509,000	$9,934,000
Total Periodic Cost	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$30,000
Total Present Value of Alternative	$73,000	$2,901,000	$10,613,000	$8,586,000	$7,819,000	$10,990,000	$33,259,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Alternative G1**
Name: **No Further Action.**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$0	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	25.73	$0	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$150,000			$72,695	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$73,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative G2** — **COST ESTIMATE SUMMARY**

Name: **MNA and Institutional Controls.**

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: Institutional controls include identification of DNAPL area. Confirmation groundwater sampling would be conducted every quarter for 2 years and then annually thereafter to assure that attenuation is occuring and that the plume is not expanding.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	ID DNAPL Area
TOTAL CAPITAL COST				**$15,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater MNA Samples		30	EA	$360	$10,800	Contractor Estimate
QC Samples		9	EA	$360	$3,240	Contractor Estimate
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est. - 5 people
Equipment - meters		4	LS	$500	$2,000	CH2M Est.
Consumables		1	LS	$500	$500	CH2M Est.
Data Validation		40	HRS	$80	$3,200	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$61,020	
Allowance for Misc. Items		20%			$12,204	
SUBTOTAL					$73,224	
Contingency		30%			$21,967	10% Scope + 20% Bid
SUBTOTAL					$95,191	
TOTAL ANNUAL O&M COST Year 0 to 2					**$761,530**	Quarterly for 2 years
TOTAL ANNUAL O&M COST Year 3 to 50					**$96,000**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$15,000	$15,000	1.000	$15,000	
ANNUAL O&M COST - Quarterly Sampling	0 to 2	$761,530	$380,765	1.913	$728,582	
ANNUAL O&M COST	3 to 50	$4,569,178	$95,191	23.816	$2,084,956	Annual Sampling
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$5,495,707			$2,901,233	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$2,901,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Alternative G3a**
Name: **In-Situ Chemical Reduction**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: ISCR includes injection of chemical amendments into the groundwater to treat the groundwater plume of CVOC concentrations greater than 1 mg/L to concentrations amenable to MNA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
Injection of ISCR Amendment					
Mobilization/Demobilization	1	LS	$15,000	$15,000	Includes submittals;
2-inch diameter concrete cores	100	EA	$120	$12,000	IPS Drilling Quote
ISCR Amendment	2,137,500	LB	$2	$3,847,500	Vendor Quotation
ISCR Amendment Injection	100	DY	$2,450	$245,000	Vendor Quotation
Injection Subcontractor Per Diem	100	DY	$250	$25,000	Project Exper
Oversight Labor	1000	HR	$80	$80,000	CH2M HILL 1 person
Oversight Per Diem	100	DY	$250	$25,000	Project Exper
SUBTOTAL				$4,249,500	
Monitoring Well Installation					
Mobilization/Demobilization	1	LS	$5,000	$5,000	Includes submittals.
Hollow-Stem Auger Drilling (4.25" ID)	360	FT	$25	$8,964	Project Exper
2-inch PVC Well Casing	280	FT	$2.90	$812	Century Products, Inc
2-inch PVC Well Screen	80	FT	$6.82	$546	Century Products, Inc.
Well Construction Materials	360	FT	$30	$10,800	Project Exper
Well Covers	16	EA	$90	$1,440	Century Products, Inc
Well Development	16	EA	$250	$4,000	Project Exper
Drilling Crew Per Diem	10	DY	$250	$2,500	Project Exper
Oversight Labor	100	HR	$80	$8,000	CH2M HILL 1 person
Oversight Per Diem	10	DY	$250	$2,500	CH2M HILL 1 person
SUBTOTAL				$44,562	
Mixing and Support Equipment					
Installation of Potable Water Line	1	LS	$50,000	$50,000	CH2M HILL Est.
5,000 Gallon Above-Ground Tank	1	EA	$7,954	$7,954	33-10- 9660
Product mixer	1	EA	$4,362	$4,362	33-13-0428
Installation of Electrical Service	1	LS	$20,000	$20,000	Project Exper
SUBTOTAL				$82,316	
SUBTOTAL				$4,391,378	
Contingency	25%			$1,097,844	10% Scope + 15% Bid
SUBTOTAL				$5,489,222	
Project Management	8%			$439,138	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	10%			$548,922	USEPA 2000, p. 5-13, $2M-$10M
Construction Management	10%			$548,922	USEPA 2000, p. 5-13, $2M-$10M
SUBTOTAL				$1,536,982	
TOTAL CAPITAL COST				$7,026,200	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater MNA Samples		30	EA	$360	$10,800	Contractor Estimate
QC Samples		9	EA	$360	$3,240	Contractor Estimate
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est. - 5 persons
Equipment - meters		4	LS	$500	$2,000	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		40	HRS	$80	$3,200	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$60,720	
Allowance for Misc. Items		20%			$12,144	
SUBTOTAL					$72,864	
Contingency		30%			$21,859	10% Scope + 20% Bid
SUBTOTAL					$94,723	
TOTAL ANNUAL O&M COST Year 0 to 3					$1,136,678	MNA Monitoring Quarterly for 3 years
TOTAL ANNUAL O&M COST Year 4 to 50					$95,000	MNA Monitoring Annually

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
					$150,000	
TOTAL ANNUAL PERIODIC COST					$150,000	

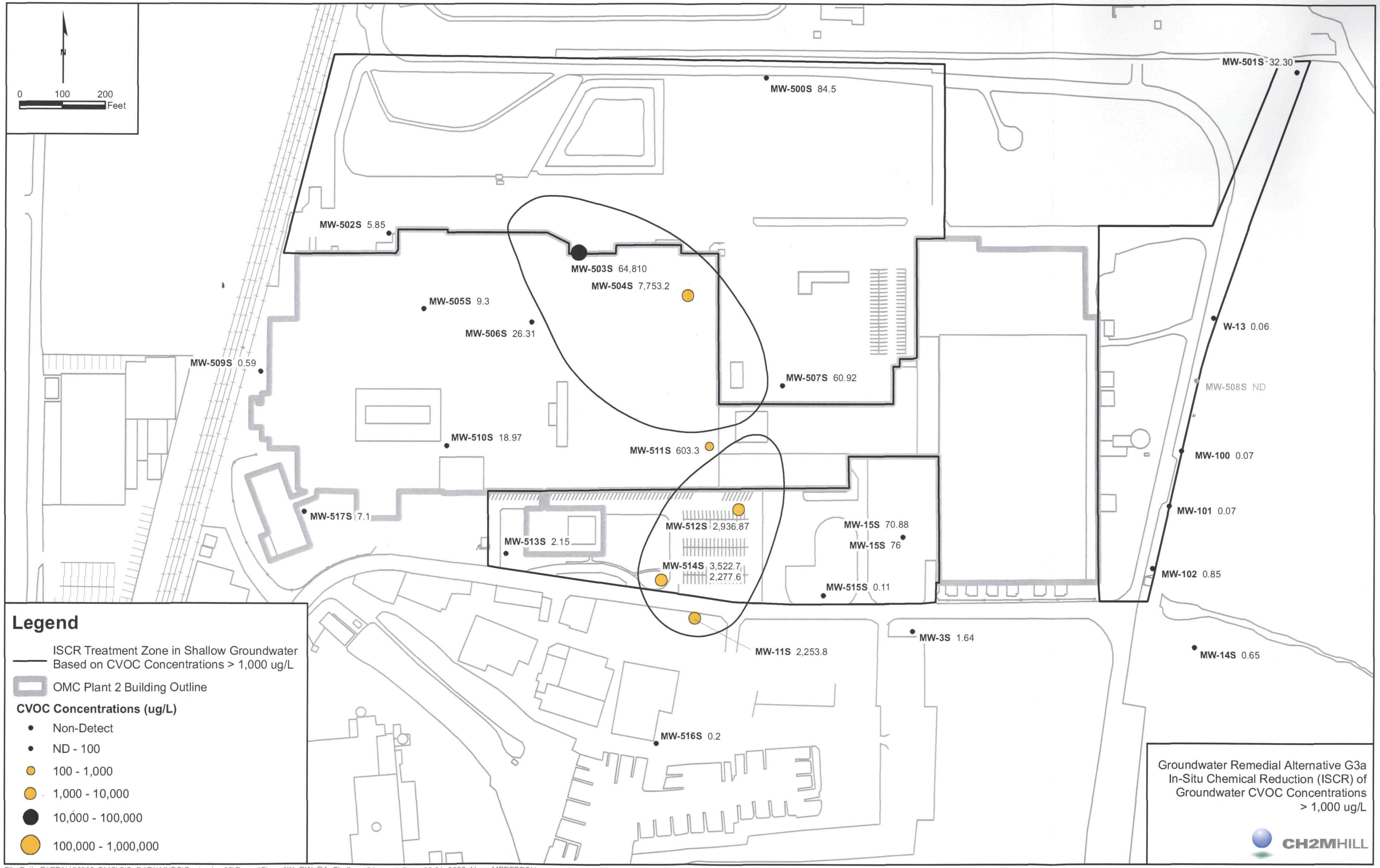
PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$7,026,200	$7,026,200	1.000	$7,026,200	
ANNUAL O&M COST - Quarterly Sampling	0 to 3	$1,136,678	$568,339	2.829	$1,607,611	
ANNUAL O&M COST	4 to 50	$4,560,000	$95,000	22.90	$1,906,891	Annual Sampling
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$12,872,878			$10,613,397	
TOTAL PRESENT VALUE OF ALTERNATIVE					$10,613,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).



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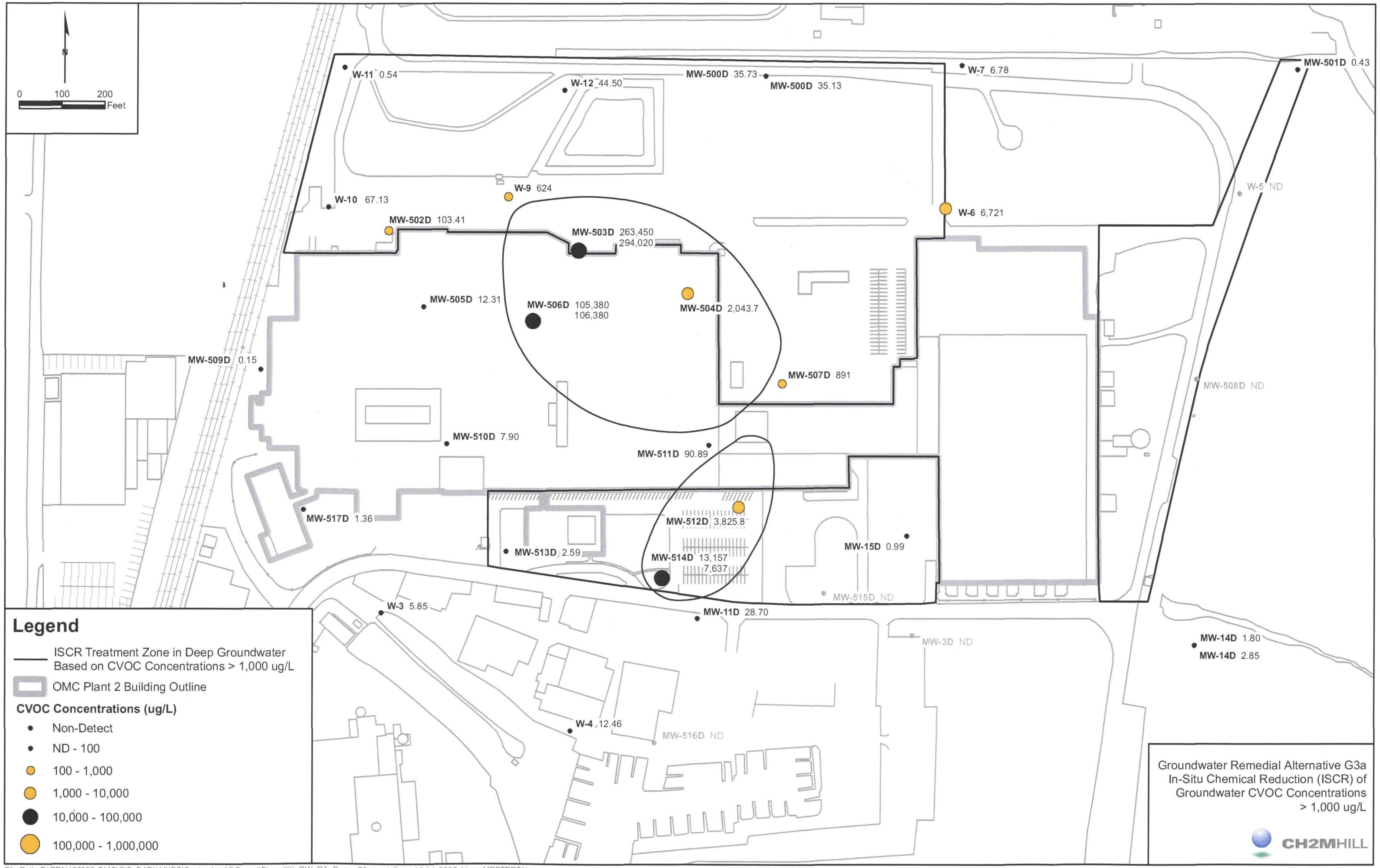

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Alternative: **Alternative G3b**

Name: **Enhanced In-Situ Bioremediation**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: EISB includes injection of biological amendments into the groundwater to treat the groundwater plume of CVOC concentrations greater than 1 mg/L to concentrations amenable to MNA.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
Injection Well Installation					
Mobilization/Demobilization	1	LS	$15,000	$15,000	Includes submittals;3 Crews
Hollow-Stem Auger Drilling (4.25" ID) for Injection Wells	9,000	FT	$25	$224,100	Project Exper
6-inch diameter concrete cores	280	EA	$245	$68,600	IPS Drilling Quote
2-inch PVC Well Casing For Injection Wells	7,200	FT	$2.90	$20,880	Century Products, Inc.
2-inch Stainless Steel Well Screen for Injection Wells	1,800	FT	$40	$72,000	Century Products, Inc.
Injection Well Construction Materials	9,000	FT	$30	$270,000	Project Exper
2-inch Locking Well Plugs for Injection Wells	360	EA	$22.00	$7,920	Century Products, Inc.
Injection Well Covers	360	EA	$90	$32,400	Century Products, Inc.
Injection Well Development	360	EA	$250	$90,000	Project Exper
Drilling Crew Per Diem	40	DY	$750	$30,000	3 crews per day
Oversight Labor	1200	HR	$80	$96,000	CH2M HILL 3 People
Oversight Per Diem	120	DY	$250	$30,000	CH2M HILL 3 people for 40 days
SUBTOTAL				$956,900	
Additional Monitoring Well Installation					
Mobilization/Demobilization	1	LS	$5,000	$5,000	Includes submittals;
Hollow-Stem Auger Drilling (4.25" ID) for Monitoring Wells	360	FT	$25	$8,964	Project Exper
6-inch diameter concrete cores	8	EA	$245	$1,960	IPS Drilling Quote
2-inch PVC Well Casing For Monitoring Wells	280	FT	$2.90	$812	Century Products, Inc.
2-inch PVC Well Screen for Monitoring Wells	80	FT	$6.82	$546	Century Products, Inc.
2-inch Locking Well Plugs for Monitoring Wells	16	EA	$22	$352	Century Products, Inc.
Monitoring Well Construction Materials	360	FT	$30	$10,800	Project Exper
Monitoring Well Covers	16	EA	$90	$1,440	Century Products, Inc.
Monitoring Well Development	16	EA	$250	$4,000	Project Exper
Drilling Crew Per Diem	10	DY	$250	$2,500	Project Exper
Oversight Labor	100	HR	$80	$8,000	CH2M HILL 1 person
Oversight Per Diem	10	DY	$250	$2,500	CH2M HILL 1 person
SUBTOTAL				$46,874	
EISB Injections					
EISB Material	837,490	LB	$1.20	$1,004,988	CH2M HILL Est.
Injection Labor	9,600	HR	$80	$768,000	CH2M HILL 2 People; 4 Inj/year; 3 years; 40 days/injection; 10 hrs/day
8-port Injection Manifold	1	EA	$350	$350	CH2M HILL Est.
80-gpm Injection Pump	1	EA	$6,500	$6,500	CH2M HILL Est.
Installation of Potable Water Line	1	LS	$50,000	$50,000	CH2M HILL Est.
Installation of Electrical Service	1	LS	$20,000	$20,000	Project Exper
5,000 gallon poly tank	1	EA	$7,954	$7,954	33-10- 9660
Product mixer	1	EA	$4,362	$4,362	33-13-0428
Injection Hoses	8	EA	$400	$3,200	CH2M HILL Est.
Injection Crew Per Diem	960	DY	$250	$240,000	CH2M HILL 2 People; 4 Inj/year; 3 years; 40 days/injection
SUBTOTAL				$2,105,354	
SUBTOTAL				$3,124,128	
Contingency	25%			$781,032	10% Scope + 15% Bid
SUBTOTAL				$3,905,160	
Project Management	8%			$312,413	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	10%			$390,516	USEPA 2000, p. 5-13, $2M-$10M
Construction Management	10%			$390,516	USEPA 2000, p. 5-13, $2M-$10M
SUBTOTAL				$1,093,445	
TOTAL CAPITAL COST				**$4,998,600**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater MNA Samples		30	EA	$360	$10,800	Contractor Estimate
QC Samples		9	EA	$360	$3,240	Contractor Estimate
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est. - 5 persons
Equipment - meters		4	LS	$500	$2,000	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		40	HRS	$80	$3,200	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$60,720	
Allowance for Misc. Items		20%			$12,144	
SUBTOTAL					$72,864	
Contingency		30%			$21,859	10% Scope + 20% Bid
SUBTOTAL					$94,723	
TOTAL ANNUAL O&M COST Year 0 to 3					**$1,136,678**	MNA Monitoring Quarterly for 3 years
TOTAL ANNUAL O&M COST Year 4 to 50					**$95,000**	MNA Monitoring Annually

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

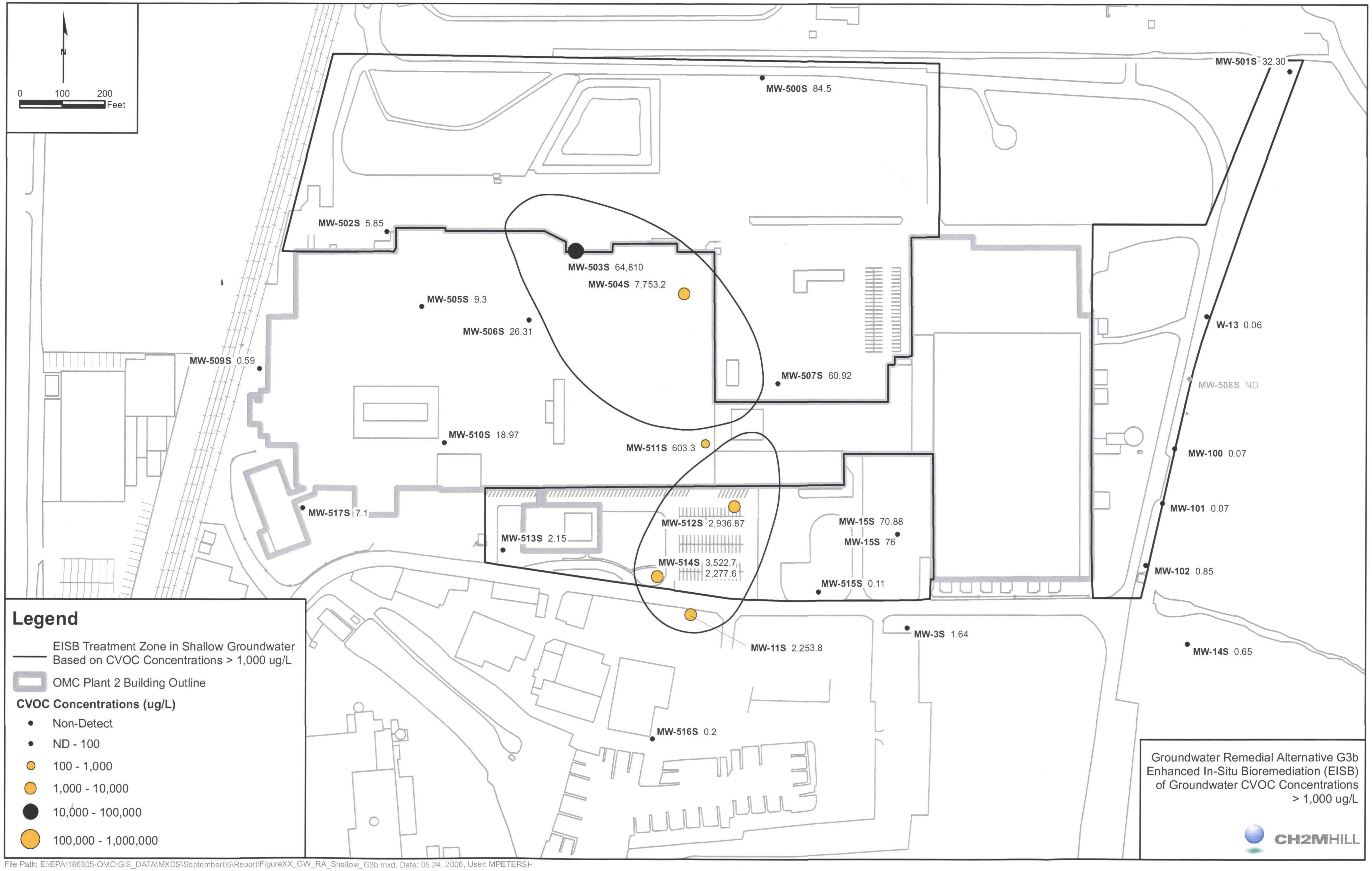
PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$4,998,600	$4,998,600	1.000	$4,998,600	
ANNUAL O&M COST - Quarterly Sampling	0 to 3	$1,136,678	$568,339	2.829	$1,607,611	
ANNUAL O&M COST	4 to 50	$4,560,000	$95,000	22.90	$1,906,891	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0.55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0.48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0.26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$10,845,278			$8,585,797	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$8,586,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).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MW-515S 0.11
MW-11S 2,253.8
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MW-14S 0.65
MW-516S 0.2
W-13 0.06
MW-508S ND
MW-100 0.07
MW-101 0.07
MW-102 0.85
Legend
EISB Treatment Zone in Shallow Groundwater Based on CVOC Concentrations > 1,000 ug/L
OMC Plant 2 Building Outline
CVOC Concentrations (ug/L)
Non-Detect
ND - 100
100 - 1,000
1,000 - 10,000
10,000 - 100,000
100,000 - 1,000,000
Groundwater Remedial Alternative G3b Enhanced In-Situ Bioremediation (EISB) of Groundwater CVOC Concentrations > 1,000 ug/L
CH2MHILL
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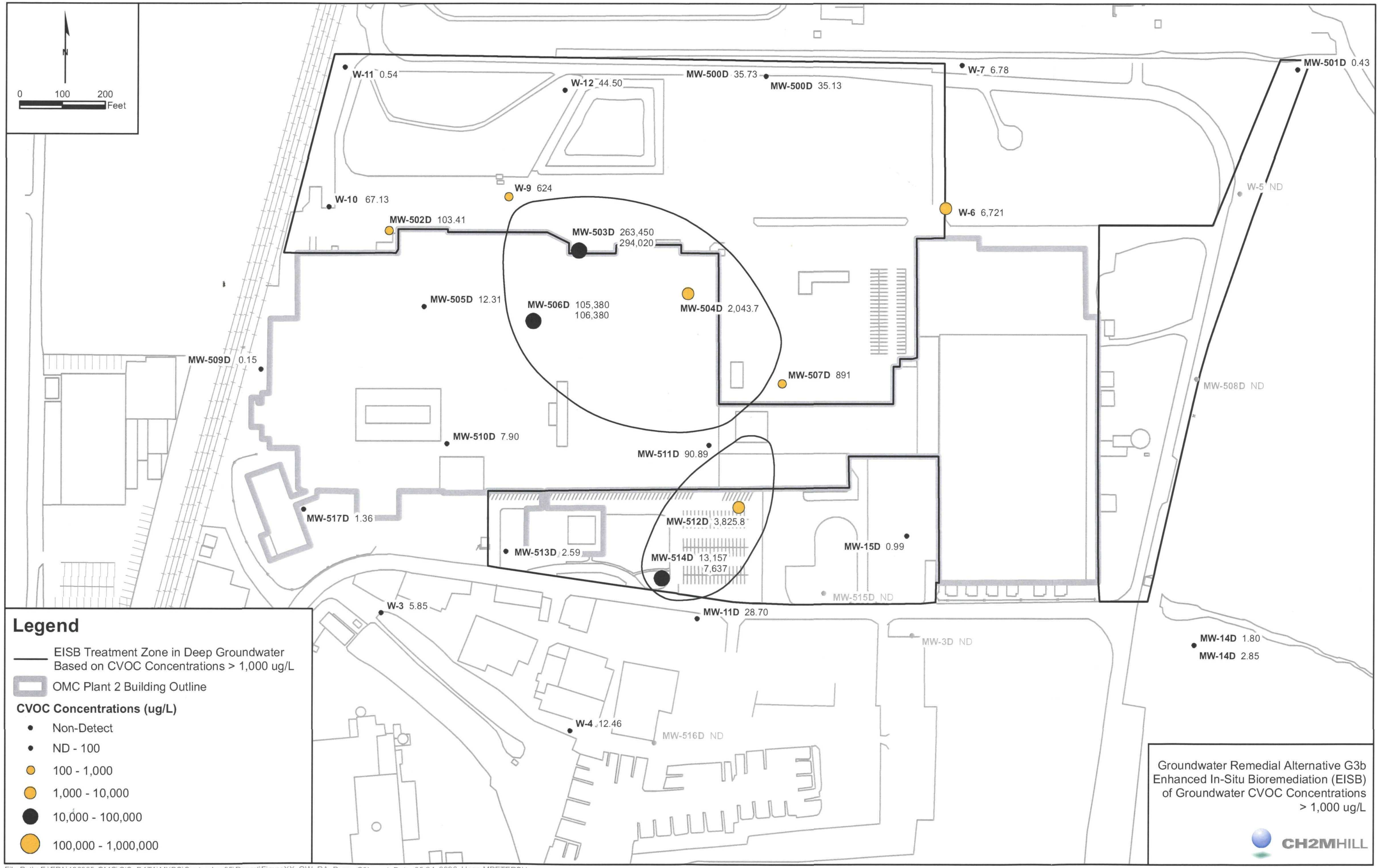

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Alternative: **Alternative G4a** — **COST ESTIMATE SUMMARY**

Name: **Groundwater Collection and Treatment with Monitored Natural Attenuation**

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: Institutional controls include Classification Exception Area. Groundwater collection with 38 - 4-inch diameter EWs and treatment using an activated carbon process with discharge of treated effluent to Lake Michigan via NPDES. Treatment continuing until groundwater concentrations are amenable to MNA, approximately 6 years.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
EW Installation					
Mobilization/Demobilization	1	LS	$25,000	$25,000	Includes submittals;
Concrete Cutting for Well Vault Installation	30	EA	$250	$7,500	CH2M HILL Est.
Hollow-Stem Auger Drilling (6.25" ID)	900	FT	$64	$57,240	IPS Drilling Quote
4-inch Carbon Steel Well Casing	585	FT	$18	$10,530	Century Products, Inc.
4-inch Stainless Steel Well Screen	585	FT	$45	$26,325	Century Products, Inc.
Well Vaults	30	EA	$1,000	$30,000	CH2M HILL Est.
Well Development	30	EA	$250	$7,500	IPS Drilling Quote
Well Construction Materials	900	FT	$30	$27,000	IPS Drilling Quote
1-inch HDPE Conveyance Piping	2,000	FT	$0.28	$560	Contractor Quotation
2-inch HDPE Conveyance Piping	500	FT	$0.83	$415	Contractor Quotation
4-inch HDPE Conveyance Piping	1,880	FT	$2 95	$5,546	Contractor Quotation
6-inch HDPE Conveyance Piping	200	FT	$6.39	$1,278	Contractor Quotation
Miscellaneous Pipe Fittings	1	LS	$25,000	$25,000	Contractor Quotation
Trenching	4,580	LF	$30	$137,400	Project Exper
Groundwater Extraction Pumps	30	EA	$1,310	$39,291	Contractor Quotation
SUBTOTAL				$400,585	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$60,000	$60,000	CH2M HILL Est
5,000 Gallon Tank	1	EA	$7,954	$7,954	RS Means 33-10- 9660
MCC	1	EA	$40,000	$40,000	CH2M HILL Est
GAC Treatment System	1	EA	$44,000	$44,000	Contractor Quotation
INC (transducers, etc)	30	EA	$2,150	$64,500	Supplier Quotation
Transfer Pump	4	EA	$6,500	$26,000	CH2M HILL Est.
PLC w/ Autodialer	1	LS	$35,000	$35,000	CH2M HILL Est.
System Programming	150	HR	$100	$15,000	CH2M HILL Est.
Fittings, Valves, Miscellaneous Appertananœs	1	LS	$20,000	$20,000	CH2M HILL Est.
Discharge Flowmeter	1	EA	$12,000	$12,000	CH2M HILL Est.
Discharge Pipe	1000	FT	$6.39	$6,390	Supplier Quotation
Mechanical Installation	25	PERCENT	$681,022	$170,255	CH2M HILL Est.
Electrical Installation	35	PERCENT	$681,022	$238,358	CH2M HILL Est
Heat Tracing	4580	FT	$10	$45,800	CH2M HILL Est.
Bag Filters	4	EA	$250	$1,000	CH2M HILL Est.
Rotating Vacuum Drum Filter	1	EA	$100,000	$100,000	Supplier Quotation
pH Adjustment Storage Tanks	2	EA	$7,954	$15,908	RS Means 33-10-9660
Mixer	3	EA	$4,362	$13,087	RS Means 33-13-0428
Mixing Tank	3	EA	$4,714	$14,141	RS Means 33-10-9658
Chemical Feeder	3	EA	$3,099	$9,297	RS Means 33-12-9905
Startup - Labor	160	HRS	$80	$12,800	CH2M Est - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
DAF System	1	EA	$123,000	$123,000	Supplier Quotation
Polymer Feed System	1	EA	$23,000	$23,000	Supplier Quotation
Dosing Pump	2	EA	$5,000	$10,000	Supplier Quotation
Air Compressor	1	EA	$5,000	$5,000	Supplier Quotation
SUBTOTAL				$1,115,490	
SUBTOTAL				$1,531,075	
Contingency	25%			$382,769	10% Scope + 15% Bid
SUBTOTAL				$1,913,843	
Project Management	6%			$114,831	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	15%			$287,077	USEPA 2000, p 5-13, $500K-$2M
Construction Management	10%			$191,384	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$593,291	
TOTAL CAPITAL COST				**$2,500,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Annual GW Sampling						
Groundwater MNA Samples		30	LS	$360	$10,800	
QC Samples		9	LS	$360	$3,240	
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est. - 5 people
Equipment - meters		4	LS	$500	$2,000	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		40	HRS	$80	$3,200	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$60,720	
Allowance for Misc. Items		20%			$12,144	
SUBTOTAL					$72,864	
Contingency		30%			$21,859	10% Scope + 20% Bid
SUBTOTAL					$94,723	
Treatment System						
Routine Operations, Maintenance, Monitoring		625	HR	$80	$50,000	
Waste Transport		11	EA	$115	$1,256	Assumes 20 tons/load non-hazardous
Waste Disposal		218	TON	$18	$3,931	Assumes non-hazardous
pH Adjustment - Acid		18,250	GAL	$1	$18,250	Assumes 98% sulfuric acid
pH Adjustment - Base		23,725	GAL	$2	$47,450	Assumes 20% NaOH
Monthly Influent/Effluent Sampling Labor		50	HR	$80	$4,000	1 Site Visit Per Month
Monthly Influent/Effluent Sampling Analytical		12	EA	$285	$3,420	VOC analysis
Data Validation, Database Management		31	HR	$80	$2,480	
O&M Project Management		1	LS	$19,618	$19,618	
Electricity		12	Months	$200	$2,400	
Reporting		1	LS	$20,000	$20,000	
Groundwater Discharge		31,536,000	GAL	$0.00	$0	Assumes NPDES Discharge
Electricity For EW Pumps		98,024	KWH	$0 08	$7,616	MEANS 33-42-0101
SUBTOTAL					$180,422	10% Scope + 20% Bid
Contingency		30%			$54,126	
SUBTOTAL					$329,271	
TOTAL ANNUAL O&M COST					**$424,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
SUBTOTAL					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$2,500,000	$2,500,000	1 000	$2,500,000	
ANNUAL O&M COST	1 to 10	$4,240,000	$424,000	8.53	$3,616,806	
ANNUAL O&M COST	11 to 50	$3,788,928	$94,723	17.20	$1,629,197	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0.64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0 55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0 48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0.41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0.36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0.31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0 26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0.23	$3,422	
		$10,678,928			$7,818,698	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$7,819,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: Alternative G4b

Name: Groundwater Collection and Treatment to MCLs

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13 21

Description: Institutional controls include Classification Exception Area
Groundwater collection with 60 - 4-inch diameter EWs
and treatment using an activated carbon process with discharge of treated effluent
to Lake Michigan via NPDES Treatment continuing until groundwater concentrations
meet MCLs, approximately 18 years

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
EW Installation					
Mobilization/Demobilization	1	LS	$25,000	$25,000	Includes submittals.
Concrete Cutting for Well Vault Installation	60	EA	$250	$15,000	CH2M HILL Est
Hollow-Stem Auger Drilling (6 25" ID)	1,800	FT	$64	$114,480	IPS Drilling Quote
4-inch Carbon Steel Well Casing	1,020	FT	$18	$18,360	Century Products, Inc
4-inch Stainless Steel Well Screen	1,020	FT	$45	$45,900	Century Products, Inc
Well Vaults	60	EA	$1,000	$60,000	CH2M HILL Est
Well Development	60	EA	$250	$15,000	IPS Drilling Quote
Well Construction Materials	1,800	FT	$30	$54,000	IPS Drilling Quote
1-inch HDPE Conveyance Piping	2,500	FT	$0 28	$700	Contractor Quotation
2-inch HDPE Conveyance Piping	500	FT	$0.83	$415	Contractor Quotation
4-inch HDPE Conveyance Piping	1,880	FT	$2 95	$5,546	Contractor Quotation
6-inch HDPE Conveyance Piping	200	FT	$6 39	$1,278	Contractor Quotation
Miscellaneous Pipe Fittings	1	LS	$44,000	$44,000	Contractor Quotation
Trenching	4,580	LF	$30	$137,400	Project Exper- M G
Groundwater Extraction Pumps	60	EA	$1,310	$78,581	Contractor Quotation
SUBTOTAL				$615,660	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$60,000	$60,000	CH2M HILL Est
5,000 Gallon Tank	1	EA	$7,954	$7,954	33-10- 9660
GAC Treatment System	1	EA	$88,000	$88,000	Supplier Quotation
MCC	1	EA	$40,000	$40,000	CH2M HILL Est.
Discharge Flowmeter	1	EA	$12,000	$12,000	CH2M HILL Est
Inc (transducers, etc)	60	EA	$2,200	$132,000	Supplier Quotation
Transfer Pump	2	EA	$6,500	$13,000	CH2M HILL Est
PLC with Autodialer	1	LS	$35,000	$35,000	CH2M HILL Est
System Programming	150	HR	$100	$15,000	CH2M HILL Est
Fittings, Valves, Miscellaneous Appertanances	1	LS	$10,000	$10,000	CH2M HILL Est
GAC Treatment System	1	EA	$88,000	$88,000	Supplier Quotation
Discharge Pipe	1,000	FT	$6 39	$6,390	Supplier Quotation
Mechanical Installation	25	PERCENT	$1,123,357	$280,839	25% of base capital cost
Electrical Installation	35	PERCENT	$1,123,357	$393,175	35% of base capital cost
Heat Tracing	4,580	FT	$10	$45,800	CH2M HILL Est
Bag Filters	4	EA	$250	$1,000	CH2M HILL Est
Rotating Vacuum Drum Filter	1	EA	$100,000	$100,000	Supplier Quotation
pH Adjustment Storage Tanks	2	EA	$7,954	$15,908	Assumes 5,000 gallon AST
Mixer	3	EA	$4,362	$13,087	RS Means 33-13-0428
Mixing Tank	3	EA	$4,714	$14,141	RS Means 33-10-9658
Chemical Feeder	3	EA	$3,099	$9,297	RS Means 33-12-9905
Startup - Labor	160	HRS	$80	$12,800	CH2M Est - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est
DAF System	1	EA	$123,000	$123,000	Supplier Quotation
Polymer Feed System	1	EA	$23,000	$23,000	Supplier Quotation
Dosing Pump	2	EA	$5,000	$10,000	Supplier Quotation
Air Compressor	1	EA	$5,000	$5,000	Supplier Quotation
SUBTOTAL				$1,557,391	
SUBTOTAL				$2,188,052	
Contingency	25%			$547,013	10% Scope + 15% Bid
SUBTOTAL				$2,735,065	
Project Management	6%			$164,104	USEPA 2000, p 5-13, $500K-$2M
Remedial Design	15%			$410,260	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	10%			$273,506	USEPA 2000, p 5-13, $500K-$2M
SUBTOTAL				$847,870	
TOTAL CAPITAL COST				**$3,582,900**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Annual GW Sampling						
Groundwater MNA Samples		30	LS	$360	$10,800	
QC Samples		9	LS	$360	$3,240	
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est - 5 people
Equipment - meters		4	LS	$500	$2,000	CH2M Est
Consumables		1	LS	$200	$200	CH2M Est
Data Validation		40	HRS	$80	$3,200	CH2M Est
Reporting		16	HRS	$80	$1,280	CH2M Est
SUBTOTAL					$60,720	
Allowance for Misc Items		20%			$12,144	
SUBTOTAL					$72,864	
Contingency		30%			$21,859	10% Scope + 20% Bid
SUBTOTAL					$94,723	
Treatment System						
Routine Operations, Maintenance, Monitoring		1,250	HR	$80	$100,000	
Waste Transport		11	EA	$115	$1,256	Assumes non-haz and 20 tons/load
Waste Disposal		218	TON	$18	$3,931	Assumes non-haz
pH Adjustment - Acid		18,250	GAL	$1	$18,250	Assumes 98% sulfuric acid
pH Adjustment - Base		23,725	GAL	$2	$47,450	Assumes 20% NaOH
Annual Influent/Effluent Sampling Labor		50	HR	$80	$4,000	1 Site Visit Per Month
Monthly Influent/Effluent Sampling Analytical		12	EA	$285	$3,420	3 VOC analytical samples per month
Data Validation, Database Management		31	Hr	$80	$2,480	
O&M Project Management		1	LS	$27,118	$27,118	
Electricity		12	Months	$200	$2,400	
Reporting		1	LS	$20,000	$20,000	
Groundwater Discharge		63072000	GAL	0 00	$0	Assumes NPDES Discharge
Electricity For EW Pumps		196048 8	KWH	$0.08	$15,233	MEANS 33-42-0101
SUBTOTAL					$245,538	10% Scope + 20% Bid
Contingency		30%			$73,661	
SUBTOTAL					$413,923	
TOTAL ANNUAL O&M COST					**$509,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
SUBTOTAL					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$3,582,900	$3,582,900	1 000	$3,582,900	
ANNUAL O&M COST,	1 to 15	$7,635,000	$509,000	11 94	$6,076,409	
ANNUAL O&M COST	15 to 50	$3,788,928	$94,723	13 79	$1,306,406	MNA Monitoring Only
PERIODIC COST	5	$15,000	$15,000	0 86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
PERIODIC COST	15	$15,000	$15,000	0 64	$9,628	
PERIODIC COST	20	$15,000	$15,000	0 55	$8,305	
PERIODIC COST	25	$15,000	$15,000	0 48	$7,164	
PERIODIC COST	30	$15,000	$15,000	0 41	$6,180	
PERIODIC COST	35	$15,000	$15,000	0 36	$5,331	
PERIODIC COST	40	$15,000	$15,000	0 31	$4,598	
PERIODIC COST	45	$15,000	$15,000	0 26	$3,967	
PERIODIC COST	50	$15,000	$15,000	0 23	$3,422	
		$15,036,828			$10,989,816	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$10,990,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000)

Alternative: **Alternative G5**

Name: **In-Situ Thermal Treatment**

COST ESTIMATE SUMMARY

Site: OMC Plant 2 (Operable Unit #4) Superfund Site, Waukegan, IL
Media: Groundwater
Phase: Feasibility Study
Base Year: 2006
Date: 12/27/2006 13:21

Description: Treatment of groundwater using thermal wells and heated extraction wells and soil-vapor extraction wells to extract volatilized contaminants
Treatment of extracted contaminants with vapor & liquid treatment system.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	
ISTD System Installation					
Mobilization & Site Prep	1	LS	$285,000	$285,000	Includes submittals,
Drilling Mobilization	3	LS	$5,000	$15,000	CH2M HILL Est
Hollow-Stem Auger Drilling (6.25" ID)	29,250	FT	$64	$1,860,300	IPS Drilling Quote
4-inch Carbon Steel Well Casing	4,875	FT	$18	$87,750	Century Products, Inc.
4-inch Stainless Steel Well Screen	24,375	FT	$45	$1,096,875	Century Products, Inc.
Well Vaults	975	EA	$1,000	$975,000	CH2M HILL Est.
Well Development	975	EA	$250	$243,750	IPS Drilling Quote
Well Construction Materials	29,250	FT	$30	$877,500	IPS Drilling Quote
Drilling Crew Per Diem	200	DY	$750	$150,000	IPS Drilling Quote
Oversight Per Diem	200	DY	$750	$150,000	CH2M HILL Est - 3 people
Well Decommissioning	975	EA	$500	$487,500	Contractor Estimate
Demobilization	1	LS	$75,000	$75,000	Contractor Estimate
Electrical Installation	1	LS	$341,700	$341,700	CH2M HILL Estimate
Electrical Connection	1	LS	$350,000	$350,000	CH2M HILL Estimate
Well Field Piping	4,580	FT	$6.39	$29,266	CH2M HILL Estimate
Shakedown Testing	1	LS	$150,000	$150,000	Contractor Estimate
SUBTOTAL				$7,174,641	
Offgas Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$60,000	$60,000	CH2M HILL Est.
5,000 Gallon Tank	1	EA	$7,954	$7,954	RS Means 33-10- 9660
MCC	1	EA	$40,000	$40,000	CH2M HILL Est.
GAC Treatment System	1	EA	$44,000	$44,000	Contractor Quotation
INC (transducers, etc)	30	EA	$2,150	$64,500	Supplier Quotation
Transfer Pump	4	EA	$6,500	$26,000	CH2M HILL Est.
PLC w/ Autodialer	1	LS	$35,000	$35,000	CH2M HILL Est.
System Programming	150	HR	$100	$15,000	CH2M HILL Est.
Fittings, Valves, Miscellaneous Appertanances	1	LS	$20,000	$20,000	CH2M HILL Est.
Discharge Flowmeter	1	EA	$12,000	$12,000	CH2M HILL Est.
Discharge Pipe	1,000	FT	$6.39	$6,390	Supplier Quotation
Mechanical Installation	25	PERCENT	$676,077	$169,019	CH2M HILL Est.
Electrical Installation	35	PERCENT	$676,077	$236,627	CH2M HILL Est.
Heat Tracing	4,580	FT	$10	$45,800	CH2M HILL Est
Bag Filters	4	EA	$250	$1,000	CH2M HILL Est.
Rotating Vacuum Drum Filter	1	EA	$100,000	$100,000	Supplier Quotation
pH Adjustment Storage Tanks	2	EA	$7,954	$15,908	RS Means 33-10-9660
Mixer	3	EA	$4,362	$13,087	RS Means 33-13-0428
Mixing Tank	3	EA	$4,714	$14,141	RS Means 33-10-9658
Chemical Feeder	3	EA	$3,099	$9,297	RS Means 33-12-9905
Startup - Labor	160	HRS	$80	$12,800	CH2M Est - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
DAF System	1	EA	$123,000	$123,000	Supplier Quotation
Polymer Feed System	1	EA	$23,000	$23,000	Supplier Quotation
Dosing Pump	2	EA	$5,000	$10,000	Supplier Quotation
Air Compressor	1	EA	$5,000	$5,000	Supplier Quotation
SUBTOTAL				$1,112,523	
SUBTOTAL				$8,302,164	
Contingency	25%			$2,075,541	10% Scope + 15% Bid
SUBTOTAL				$10,377,706	
Project Management	6%			$622,662	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	15%			$1,556,656	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	10%			$1,037,771	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$3,217,089	
TOTAL CAPITAL COST				**$13,600,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater MNA Samples		30	LS	$360	$10,800	
QC Samples		9	LS	$360	$3,240	
Groundwater Sampling, Level D						
Labor		500	HRS	$80	$40,000	CH2M Est
Equipment - meters		4	LS	$500	$2,000	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		40	HRS	$80	$3,200	CH2M Est
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$60,720	
Allowance for Misc. Items		20%			$12,144	
SUBTOTAL					$72,864	
Contingency		30%			$21,859	10% Scope + 20% Bid
SUBTOTAL					$94,723	
Treatment System						
Routine Operations, Maintenance, Monitoring		625	HR	$80	$50,000	
Waste Transport		11	EA	$115	$1,256	Assumes 20 tons/load non-hazardous
Waste Disposal		218	TON	$18	$3,931	Assumes non-hazardous
pH Adjustment - Acid		18,250	GAL	$1	$18,250	Assumes 98% sulfuric acid
pH Adjustment - Base		23,725	GAL	$2	$47,450	Assumes 20% NaOH
Monthly Influent/Effluent Sampling Labor		50	HR	$80	$4,000	1 Site Visit Per Month
Monthly Influent/Effluent Sampling Analytical		12	EA	$285	$3,420	VOC analysis
Data Validation, Database Management		31	HR	$80	$2,480	
O&M Project Management		1	LS	$19,618	$19,618	
Electricity		12	Months	$200	$2,400	
Reporting		1	LS	$20,000	$20,000	
Groundwater Discharge		12	LS	$0.00	$0	Assumes NPDES Discharge
Electricity For ISTD System Operation		90,000,000	KWH	$0.08	$6,993,000	MEANS 33-42-0101
ISTD System O&M		2	YR	$165,000.00	$330,000	
SUBTOTAL					$7,495,805	
Contingency	30%				$2,248,742	10% Scope + 20% Bid
SUBTOTAL					$9,839,270	
TOTAL ANNUAL O&M COST					**$9,934,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
SUBTOTAL					$30,000	
TOTAL ANNUAL PERIODIC COST					**$30,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$13,600,000	$13,600,000	1.000	$13,600,000	
ANNUAL O&M COST (system operation)	1 to 2	$19,868,000	$9,934,000	1.91	$19,008,408	
ANNUAL O&M COST (MNA only)	3 to 10	$757,786	$94,723	6.62	$626,758	
PERIODIC COST	5	$15,000	$15,000	0.86	$12,939	
PERIODIC COST	10	$15,000	$15,000	0.74	$11,161	
		$34,255,786			$33,259,267	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$33,259,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000)

Appendix C

Estimation of Industrial Risk

Estimation of Potential Risk to Industrial Workers OMC Plant 2, Waukegan, Illinois WA No. 018-RICO-0528, Contract No. EP-S5-06-01

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DATE:	November 16, 2006
PROJECT NUMBER:	348138.DE.01

Introduction

The purpose of this memorandum is to document the assumptions and results of estimating the potential risks to an industrial worker exposed to the contaminated surfaces existing in the Outboard Marine Corporation (OMC) Plant 2 building. This evaluation provides a supplemental exposure scenario to that presented in the *Remedial Investigation Report*.[1]

Discussion

The human heath risk assessment (HHRA) in the RI report evaluated potential human health risks specific to the building that were based on the current land-use scenario. This exposure scenario consisted of trespassers who might enter the OMC Plant 2 building and come into contact with the polychlorinated biphenyls (PCBs) at concentrations currently detected on the building surfaces. This exposure scenario was associated with an excess lifetime cancer risk (ELCR) of 2×10^{-5}.

This supplemental assessment evaluates the potential human health risk to industrial workers who are assumed to be exposed to the same contaminated surfaces and materials inside the plant as the trespassers. The objective of the evaluation is to estimate potential future risks if the PCB-contaminated materials within the plant are not addressed prior to use for industrial purposes.

The cumulative risk estimates presented in this memorandum are based on U.S. Environmental Protection Agency (USEPA) guidelines and are consistent with the methods and assumptions presented in Appendix E of the RI report, with the following modifications:

- **Exposure pathways and potentially exposed populations**—The contamination source is PCB-1248 (Aroclor-1248) on surfaces and materials inside the existing plant. The building, by its very nature, is ideally suited to industrial applications where, if used in this capacity again, workers could potentially be exposed to contaminated surfaces by direct dermal contact, making them a valid receptor population with the potential for a completed exposure pathway.

[1] CH2M HILL. 2006. *Remedial Investigation Report, OMC Plant 2, Waukegan, Illinois*. April.

- **Exposure assessment**—The exposure assessment used in this evaluation includes a frequency, duration and skin surface area that are consistent with a reasonable maximum exposure (RME) occupational scenario[2] including an exposure frequency of 250 days/year over a 25-year period, and a dermal surface area of 3,900 cm^2.[3] The Exposure Point Concentrations (EPC) are presented in Table 1 and are the same as for the current-use trespasser evaluated in Appendix E and presented in Section 5 of the RI Report.

TABLE 1
Wipe Sample Results for Arochlor-1248
OMC Plant 2
Waukegan, IL

Surface	Number of Samples	Maximum Detected Concentration	Mean	Standard Deviation	EPC	Units
Non-porous	62	600	104	119	134	ug/100cm2
Porous	63	750	48.1	134	216	ug/100cm2
Combined	125	750	75.7	130	97.7	ug/100cm2

The exposure assumptions and the toxicity values for PCB-1248 are shown in Tables 2 and 3, respectively.

TABLE 2
Exposure Assumptions and Parameters for Estimating Cancer Risk from Contact with Contaminated Surfaces
OMC Plant 2
Waukegan, IL

Pathway		Exposure Parameters								Summary Intake Factor
Media	Exposure Route	Skin Surface Area (cm^2)	Exposure Frequency (d/yr)	Exposure Duration (yr)	Number of Contacts per Day (d^{-1})	Body Weight (kg)	Fraction Transferred to Skin	Conversion Factors (mg/ug)	Averaging Time (yr x d/yr)	(cm2*mg)/(kg*ug*d)
Surface - Trespass	Dermal	420	99 [b]	7	1	70	0.5	1.00E-03	70 x 365	8.1E-05 x ABS
Surface - Occupational	Dermal	3900 [a]	250 [c]	25 [c]	1	70	0.5	1.00E-03	70 x 365	6.8E-03 x ABS

[a] Hands and arms, adult male, 50th percentile. U.S. EPA. Exposure Factors Handbook, 1997.

[b] Exposure frequency is 50% of the average (1971-2000) number of days during April through October with minimum temparatures higher than 32 degrees Fahrenheit at climate station 119029 WAUKEGAN 2 WNW, IL. (http://mrcc.sws.uiuc.edu/climate_midwest/historical/grow/il/119029_gsum.html).

[c] OSWER Directive 9285.6-03, 1991 Risk Assessment Guidance for Superfund, Vol. 1 Human Health Evaluation Manual, Supplemental Guidance.

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2 OSWER Directive 9285.6-03, 1991. *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual Supplemental Guidance. Standard Exposure Factors.*

3 This represents hands and arms for an adult male, at the 50th percentile. U.S. EPA. 1997. *Exposure Factors Handbook.*

TABLE 3
Toxicological Information for Arochlor-1248
OMC Plant 2
Waukegan, IL

Chemical	Oral Slope Factor[a] $(mg/kg\text{-}day)^{-1}$	Dermal Absorption Factor[b]
Aroclor-1248	2	0.14

[a] from Iris 11/14/05

[b] from EPA 2004. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Exibit 3-4 Recommended Dermal Absorption Fraction from Soil

Risk Assessment Results

The exposure pathway was assumed to be associated with an industrial worker who could have dermal contact with PCB-contaminated surfaces and materials while working in the existing plant building.

Risk-based values and human health risks were calculated using the processes described in Appendix E of the RI Report with the frequency, duration, and skin surface area adjusted for an industrial worker.

Comparison of Wipe Sample EPCs to Remediation Objectives

The EPC for combined porous and nonporous surfaces was 97.7 micrograms (μg)/100 cm^2. This number was compared to the risk-based values which correspond to ELCR of 1×10^{-6} and 1×10^{-4}. Table 4 shows that the EPCs exceed risk-based remediation objectives for this range of carcinogenic risks.

TABLE 4
Comparison of Wipe Sample EPCs for Arochlor-1248 to Remediation Objectives
OMC Plant 2
Waukegan, IL

Chemical	Exposure Scenario	Calculation of Intake Factors per Unit Concentration (cm2*mg)/(kg*ug*d)	Cancer Risk Level	Remediation Objective for Surfaces Based on Cancer Risks		Wipe Sample EPCs for Arochlor-1248 (ug/100 cm^2)			EPCs exceed Remediation Objective?
				(ug/cm^2)	(ug/100 cm^2)	Non-Porous (bare metal)	Porous (painted surfaces, concrete, etc.)	Combined (Porous and Non-Porous)	
Aroclor-1248	Trespasser - Dermal	1.14E-05	1E-06	0.044	4.4				Yes
Aroclor-1248	Occupational - Dermal	9.54E-04	1E-04	0.052	5.2	134.3	216.4	97.7	Yes
Aroclor-1248	Occupational - Dermal	9.54E-04	1E-06	0.001	0.1				Yes

Calculation of RME Chemical Cancer Risks for Porous and Non-Porous Surfaces—Industrial Worker

The ELCR associated with potential contact with contaminated surfaces and materials by industrial workers inside the existing plant building is 2×10^{-3}. Intake and carcinogenic risk are summarized in Table 5.

TABLE 5
Calculation of RME Chemical Cancer Risks for Porous and Non-Porous Surfaces - Occupational (Factory Worker) Scenario
OMC Plant 2
Waukegan, IL

Chemical	CAS	Wipe Sample Exposure Point Concentration (ug/100 cm^2)	Dermal Slope Factor (SF) (kg-day/mg)	ABS Unitless	Carcinogenic Estimated Dermal Intake (cm2*mg)/(kg*ug*d)	Carcinogenic Dermal ELCR (Intake * SF)	Carcinogenic Excess Cancer Risk (Intake * SF)
PCB-1248 (Aroclor 1248): Trespass	12672-29-6	9.77E+01	2.0E+00	1.4E-01	8.1E-05	2.3E-05	**2E-05**
PCB-1248 (Aroclor 1248): Occupational	12672-29-6	9.77E+01	2.0E+00	1.4E-01	6.8E-03	1.9E-03	**2E-03**

Notes:

Wipe sample results provided for combined interior non-porous wipe samples (bare metal) and interior porous wipe samples (painted surfaces, concrete, etc.).